PB-228 206

BIOLOGICAL SURVEY OF THE KANSAS RIVER BASIN

Ross E. Powers, et al

Federal Water Pollution Control Administration
Kansas City, Missouri

1966

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 228 206

CU7375

BIOLOGICAL SURVEY OF
THE KANSAS RIVER BASIN
1966

by

ROSS E. POWERS

and

GERALD Z. JACOBI
Aquatic Biologists

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Missouri Basin Region
Kansas City, Missouri

TABLE OF CONTENTS

	Page No.
ACKNOWLEDGMENTS	iii
SUMMARY AND CONCLUSIONS	1
INTRODUCTION	4
History of Previous Biological Studies	4
Basin Description	4
Purpose	6
Pollution Problems	6
Field Investigations	8
Laboratory Procedures	10
RESULTS AND DISCUSSION	11
Physical Observations	11
Chemical Observations	12
Benthos	13
Phytoplankton	19
BIBLIOGRAPHY	24
APPENDIX	
Tables 1 through 21	

FIGURE INDEX

Figure No.	Title	Follows Page No.
1	Location Map	4
2	Seasonal Survey Station Location	8
3	Reconnaissance Surveys Station Location. . .	9
4	Lower Kansas River Station Locations	9
5	Lower Kansas River Summer Survey, Benthos. .	18
6	Lower Kansas River Fall Survey, Benthos. . .	18
7	Spring Survey, Phytoplankton	20
8	Summer Survey, Phytoplankton	20
9	Fall Survey, Phytoplankton	20
10	Reconnaissance Survey, Phytoplankton	22
11	Lower Kansas River Summer Survey, Phytoplankton.	22
12	Lower Kansas River Fall Survey, Phytoplankton.	22

ACKNOWLEDGMENTS

Specific appreciation is expressed for the assistance and cooperation of the following agencies:

Kansas State Department of Health, Environmental Health Services Division, Topeka, Kansas

Corps of Engineers, Kansas City District, Kansas City, Missouri

Federal Water Pollution Control Administration, Water Quality Activities, Aquatic Biology Section, Cincinnati, Ohio

Federal Water Pollution Control Administration, Technical Advisory and Investigations Activities, Biological and Chemical Unit, Cincinnati, Ohio

University of Kansas, Center for Research, Inc., Engineering Science Division, Lawrence, Kansas

Analytical Laboratory of the State Geological Survey of Kansas, Lawrence, Kansas

SUMMARY AND CONCLUSIONS

Summary

A biological survey of the Kansas River below the six large reservoirs was conducted during the spring, summer, and fall of 1966. Benthic and phytoplankton samples were taken and the results tabulated in conjunction with a chemical water quality study of the river. The results of the seasonal chemical and biological surveys were reported to the University of Kansas Center for Research for incorporation and use in their mathematical model of the river. Special biological studies of the upstream areas and an intensified study of the lower reach near the river's mouth were also made. A total of 175 benthic samples and 128 phytoplankton counts were processed during this study.

Conclusions

Physical observations of the river characteristics noted its high turbidity, shallow water, large flow fluctuation, sand and silt bottom, and the grossly polluted reach in Kansas City, Kansas. Chemical observations pointed out several harsh conditions that would discourage the development of a balanced aquatic fauna. Evidence of organic pollution was found, but the direct results of the pollution on the life in the river were only found directly below the source. The cumulative results of the organic pollution became apparent after noting the increase in phytoplankton production in downstream areas.

Soluble pollutants in the river were continually being diluted by the water stored in the alluvial valley during low river stages. Conversely, the alluvial bank storage was continually being recharged by river water, particularly during high water conditions. This exchange of water, in effect, dispersed and diluted the soluble contaminants in the river.

Aquatic macroinvertebrates in the Kansas River survived quite well despite such physical hardships as large variations in flow and shifting sand bottoms. Salty and turbid conditions also discouraged the existence of certain forms. Because of the shallowness of the river, and the high populations of oxygen producing algae, the dissolved oxygen (D.O.) remained at a level sufficient to support a variety of aquatic organisms. Stoneflies, caddisflies and mayflies, which are intolerant of D.O. deficiencies, were found throughout almost all of the river basin. However, they were abundant only when a suitable attachment surface was available. The shifting sand bottom discouraged the establishment of aquatic benthic organisms and prevented the buildup of sludge banks. Pollution tolerant organisms thrived only in areas which received a constant replenishment of settleable organics.

The Kansas River Basin supported large phytoplankton populations. Generally, these populations increased in the downstream areas; however, local enrichment caused blooms to occur in some upstream areas. There were, generally, more than adequate concentrations of nutrient materials in the waters and toxic industrial materials were absent. Taste and odor-producing algae were not found except in Kirwin Reservoir.

The Saline, Solomon, and Republican Rivers are the tributaries which supported the largest phytoplankton populations. The Delaware, Big Blue, and the Smoky Hill, above Salina, had only moderate plankton populations.

The plankton and benthos populations were influenced dramatically by flood waters, which brought high turbidities and deeper waters. Flusing and diluting effects also reduced their population densities.

The construction of reservoirs throughout the basin may reduce downstream turbidities and provide better conditions for algal growth. The phenomenal increase in livestock raising in this basin may cause an increase in the fertilization of the river despite improvements in municipal waste treatment and disposal methods. The combined results of these two factors may further impair the use of the river as a source of municipal water supplies.

INTRODUCTION

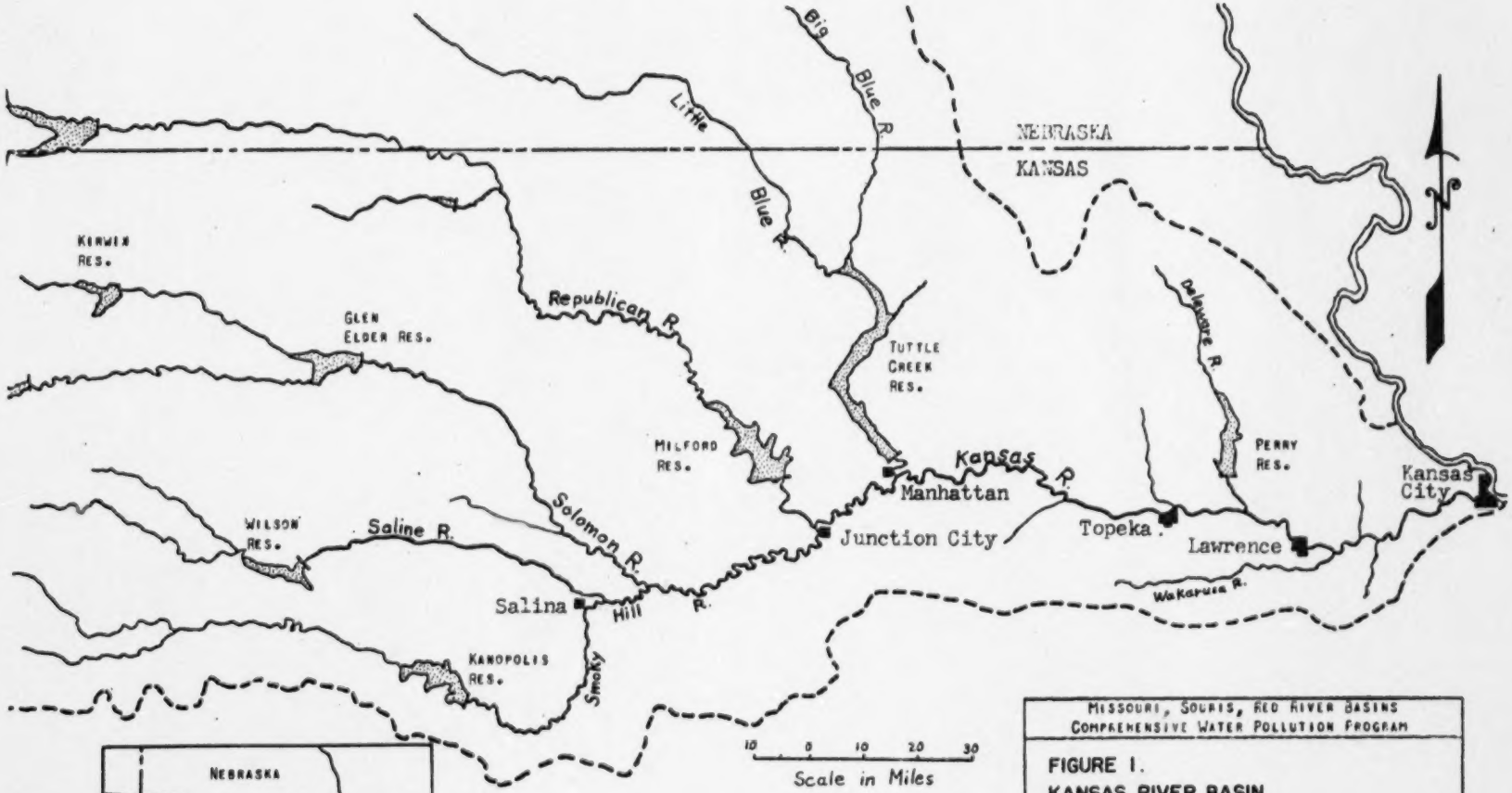
History of Previous Biological Studies

There are numerous reports on the chemical and bacteriological water quality of the Kansas River system, however, biological research has been either short in duration or limited in scope and study area. Much of the early data are incidental references to reports and bulletins of the Forestry, Fish and Game Commission and the Kansas Academy of Science. The Academy of Natural Sciences of Philadelphia, conducted a detailed survey of a very short segment of the Kansas River in 1959 (1). In 1966 Metcalf described the distribution of fishes in the Kansas River Basin (2). Biological surveys of the phytoplankton and benthic organisms were recently done by the Federal Water Pollution Control Administration on the Big Blue River (3), Wilson (4)(5) and Tuttle Creek Reservoirs (6)(7).

Basin Description

The Kansas River Basin is an area of approximately 60,000 square miles, and lies within the States of Colorado, Nebraska, and Kansas (Figure 1). The Kansas River (Kaw) proper is formed by the junction of the Smoky Hill and Republican Rivers at Junction City, Kansas. It flows 170 river miles in an easterly direction to its confluence with the Missouri River at Kansas City.

The principal tributaries are: the Smoky Hill, Republican, Big Blue, and Delaware Rivers. The Saline and Solomon Rivers are the major tributaries of the Smoky Hill.



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 1.
KANSAS RIVER BASIN
LOCATION MAP

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI

The topography of the Kansas River Basin is typical of prairie country. The rolling plains rise from an elevation of 750 feet near the mouth to about 5,500 feet at the western end of the basin. The larger rivers occupy wide alluvial valleys (about 1 to 2 miles) throughout the lower two-thirds of their length. The entire Kansas Basin lies within the Great Plains physiographic region.

The bedrock is largely sedimentary in orgin, predominately limestone, siltstone, shale, and fine sandstone. Glacial deposits are confined to a small area of the north eastern corner of the basin. Alluvium consisting of sand, gravel, silt, and clay fills the flood plains.

The basin has a subhumid climate, with precipitation increasing from the semiarid west to a humid condition in the east. The average rainfall is approximately 26 inches per year. Torrential rains occur in May, June, and July and often produce extensive floods and soil erosion.

Metcalf (2) reported that nineteenth century explorers observed the larger streams in this basin and reported that they often fluctuated in the amount of discharge and turbidity. Fluctuations in flow often cause floods or intermittency in the upland tributaries. Historically, shifting sand bars and shallow waters have prevented navigation of the lower Kansas River.

The Kansas River Basin now has 14 Federal reservoirs in operation for irrigation and flood control. These reservoirs are also used for fishing, boating, and swimming.

Purpose

A chemical and biological study of the Kansas River drainage system was initiated to establish accurately parameters which would describe the behavior of the drainage system for evaluation of a mathematical river model. The University of Kansas Center for Research, Incorporated, entered into contract with the Federal Water Pollution Control Administration (FWPCA) to establish a mathematical model which would simulate the hydraulics of the lower river system and predict the distribution of pollutants and the location of critical pollution areas under various river conditions (8). The Kansas State Department of Health contracted separately to conduct time of flow studies and establish present water quality conditions. In addition, a chemical and biological study of the lower reaches of the Kansas River was requested from the Technical Advisory and Investigations Activities of the FWPCA in March 1966. Later biological studies were completed by the Kansas City Office of the FWPCA. The purpose of these biological surveys was to determine the populations of phytoplankton organisms at the University of Kansas mathematical model stations in the lower reach of the Kansas River Basin. To further investigate the effects of pollution discharges on the aquatic life of the river basin, biological investigations were also made to determine the extent and nature of existing degradation and to document the existing biological condition of this river basin.

Pollution Problems

The major sources of municipal wastes discharged to the Kansas River system are from large cities such as Topeka, Lawrence, Manhattan,

Junction City, Abilene, Salina, and the Kansas Citys. These large cities account for 80 percent of the population equivalents discharged by municipalities. Other substantial sources of pollution include the cities of Beloit, Minneapolis, Concordia, Belleville, Clay Center, Fort Riley, Ogden, Eudora, Wamego, Horton, Marysville, Sabetha, Hays, Olathe, Bonner Springs, and Mission Township Sewage Disposal No. 1 in Kansas.

In Nebraska, Fairbury, Beatrice, McCook, Superior, Red Cloud, and Benkelman discharge considerable amounts of domestic sewage.

In some areas of this basin, organic stream pollution does not pose a serious health problem because the streams are not used for domestic water supplies. However, Topeka, Lawrence, and Johnson County Water District No. 1 (serving 110,000 people) all obtain their raw water from the Kansas River main stem. The cities of Beloit, Salina, Tonganoxie, Valley Falls, and Marysville, Kansas, use tributary waters.

Use of the Kansas River by industry is substantial only on the lower main stem between Topeka and Kansas City. Industrial wastes in this basin are predominately associated with the food processing industries which constitute 27 percent of the total manufacturing in the basin. Slaughtering, rendering, and meat packing plants, dairies and canneries are the principal industries. Other industrial waste sources include oil refineries, ordnance works, and soap and paper manufacturers. The operation of large cattle feed lots is presently a major source of organic pollution. In eleven years between 1955 and 1967, the number of

cattle in Kansas has increased by 400,000 head. Feed lots of over 300 head now number about 150 in the State. All reported fish kills in 1965 in Kansas were caused by feed lot drainages or food processing wastes.

Damage to public water supplies from improper oil field brine disposal is no longer a problem due to a successful brine pollution control program carried out by the Kansas State Board of Health. However, chlorides and sulfates are leached from natural salt deposits in some areas of the basin, and degrade or prevent the use of surface waters for domestic water supplies.

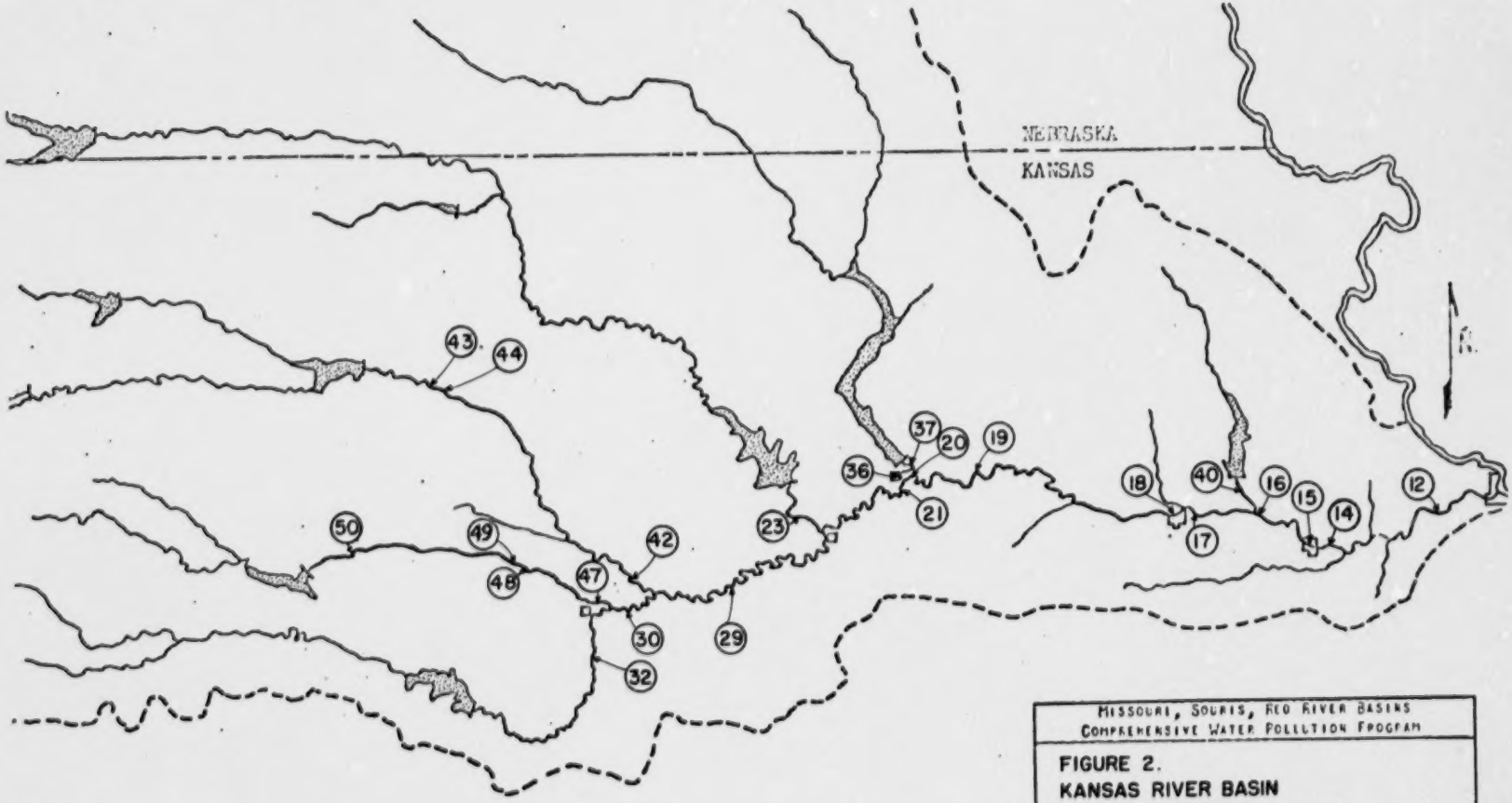
Clay suspensions give a beige appearance to the water especially during times of high water. Fluctuating water levels and heavy runoffs from thunderstorms keep the rivers fairly turbid much of the year.

Taste and odor problems at water treatment plants have occurred at Topeka, Lawrence, and Johnson County, Kansas.

Field Investigations

The field investigation sampling program consisted of: three seasonal collections, spring, summer, and fall, in the mathematical model study area; a reconnaissance of the upstream areas and small tributaries; and two surveys of the lower river near the mouth at Kansas City.

The primary area of study was the Kansas River Basin mathematical model area; the lower river basin bounded upstream by six large reservoirs. The sampling locations in this area were selected by the University of Kansas Center for Research, Incorporated, and are currently used by the United States Geological Survey and the Kansas State Health Department



Missouri, Souris, Red River Basins
Comprehensive Water Pollution Program

FIGURE 2.
KANSAS RIVER BASIN
SEASONAL SURVEYS, 1966
STATION LOCATIONS

U. S. Dept. of the Interior
Federal Water Pollution Control Administration
Missouri Basin Region Kansas City, Missouri

(Table 1) (Figure 2). Additional sampling sites were selected during the study to further investigate water conditions downstream from known pollution sources and upstream from the large reservoirs (Figure 3). The lower Kansas River special study area included only 9.3 river miles within Kansas City, Kansas.

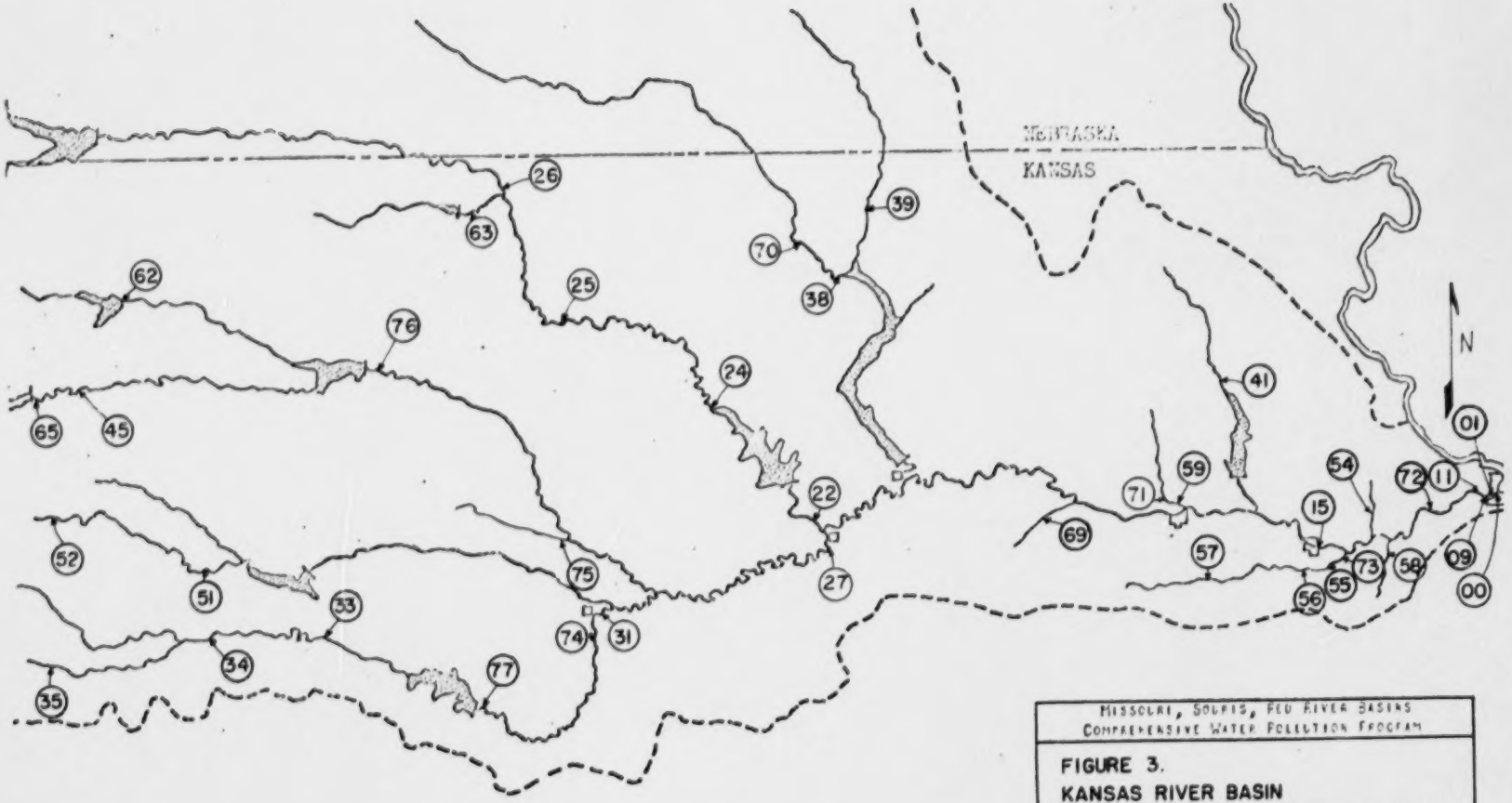
Physical observations such as water color, odor and temperatures, weather conditions, bottom types, and Secchi disc readings were noted at each sampling site.

Chemical and bacteriological water quality studies were conducted at the same time, but only in the mathematical model area as described above.

Benthos or bottom-dwelling organisms were collected with Surber samplers and Eckman and Petersen dredges for quantitative analysis. The dredged bottom material was sifted through a 30-mesh sieve and the concentrated assemblage of organisms preserved in 40 percent formalin. Aquatic dip net collections, hand picking, and artificial substrate collections are reported as qualitative samples. Because of the large fluctuations in river stages, quantitative benthic samples were not always obtainable.

During the lower Kansas River survey, three Eckman dredge samples were obtained transecting the river (Figure 4). Each transect sample was screened, preserved, and labeled separately.

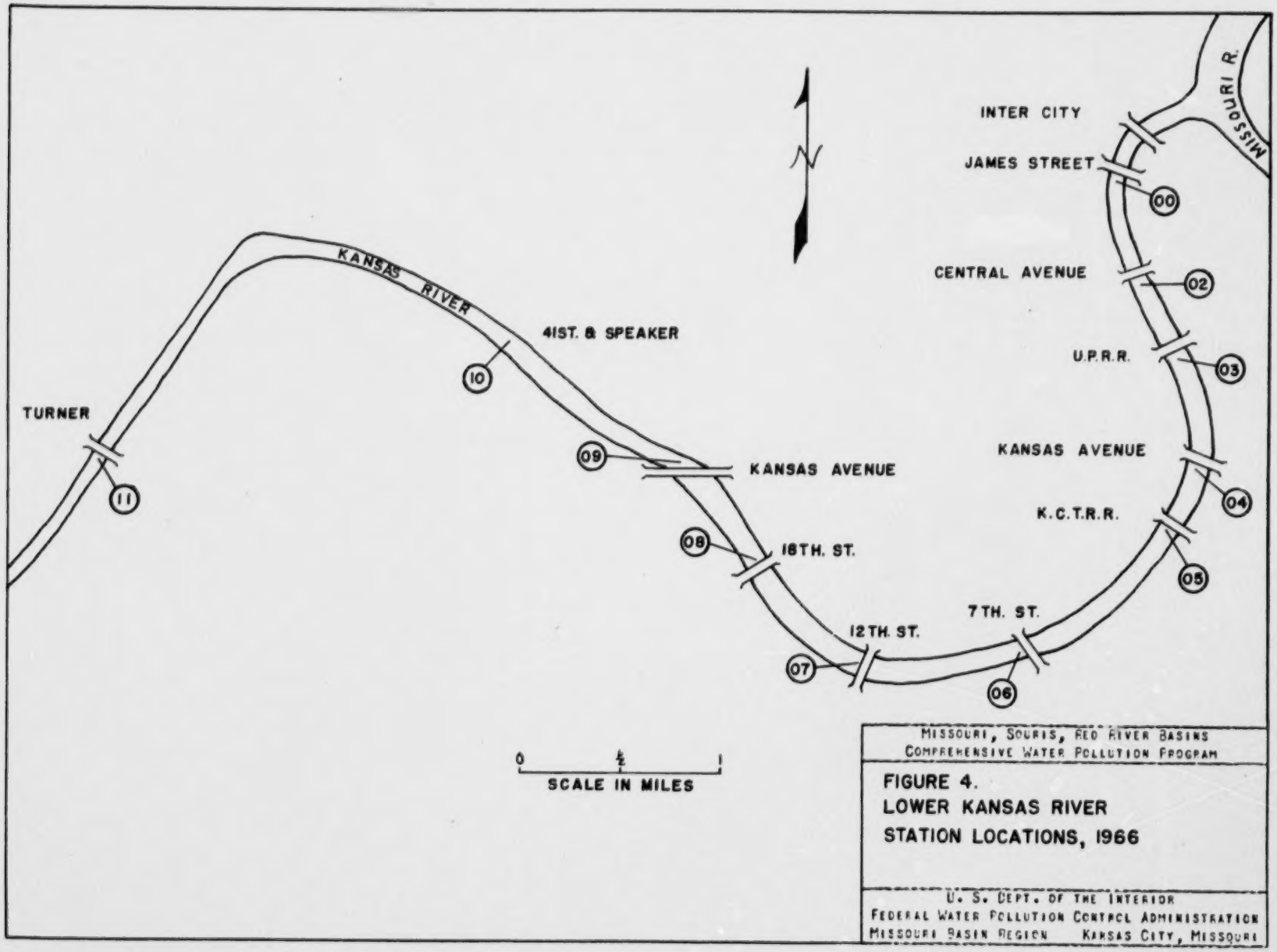
Phytoplankton samples were collected at a depth of 6 inches and preserved in 70 ml bottles containing a 4 percent formalin solution. Attached algae and slime samples were preserved separately in 40 percent formalin solutions.



Missouri, Souris, Red River Basins
Comprehensive Water Pollution Program

FIGURE 3.
KANSAS RIVER BASIN
RECONNAISSANCE SURVEYS, 1966
STATION LOCATIONS

U. S. Dept. of the Interior
Federal Water Pollution Control Administration
Missouri Basin Region Kansas City, Missouri



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 4.
LOWER KANSAS RIVER
STATION LOCATIONS, 1966

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI

Laboratory Procedures

Preserved phytoplankton samples were counted and identified under 210 magnifications using a Sedwick-Rafter counting cell as described in Standard Methods (9). A differential strip-count was made of the unconcentrated samples. The phytoplankton organisms found were identified to the generic level and recorded as number per milliliter. Extremely turbid samples were diluted with a measured amount of distilled water until they could be counted.

Periphyton samples were not quantitatively analyzed. The predominate genera and total number of genera were noted for later reference and recorded under physical observations.

The quantitative benthic organism collections were carefully sorted and the number of each species was recorded. The results are expressed in numbers of organisms per square foot of bottom.

The relative abundance of benthic organisms was found through the identification of the invertebrates collected in the qualitative samples. The qualitative results are reported as number of kinds of organisms and the predominate genera are noted.

RESULTS AND DISCUSSION

Physical Observations

The spring, summer and fall surveys found that the Kansas River system was usually turbid, and beige in color, regardless of the season (see Tables 2, 3, 4). Secchi disc readings were low during the summer months, but rarely exceeded 2 feet in depth at any time of the year. The spring survey Secchi disc readings ranged from 0.5 to 2.5 feet, summer readings ranged from 0.1 to 1.2 feet, and fall readings from 0.1 to 2.0 feet.

The predominate bottom type throughout this river basin was a sand and silt mixture. Extensive sludge deposits were not found during the seasonal surveys of the Kansas River Basin. The maximum depth ranged from 1 to 5 feet.

The odors of the water and bottom materials were normal at most stations, except those directly below sewage treatment works. Estimated water qualities were good except at Stations 17 and 20 below the sewage treatment plants of Manhattan and Topeka, Kansas.

A reconnaissance outside of the model study area found much the same physical conditions as those found during the seasonal surveys (Table 5). The predominate bottom type was shifting sand and silt. The water depths varied from 1 to 5 feet. Only at Stations 00 and 01 were water quality conditions badly degraded. Station 09 may have suffered from industrial pollution as the bottom was covered with an oily substance. The Wakarusa and Big Soldier Creeks were thought to be degraded also.

The lower Kansas River special study area is all within the Kansas City, Kansas, city limits. The summer survey of this area found a soft silty bottom in the lower reaches. The depths varied from 28 feet near the river mouth to 6 feet at River Mile 5.2. Polluted conditions were noted from ST-09 to the river's mouth (Table 6). Nauseous odors and rotting meat packing wastes fouled the river below ST-05.

The fall survey found the lower river reaches much shallower (Table 7). The maximum depth at the mouth was 18 feet, and this rapidly declined to 5 feet at River Mile 5.2. Extensive sludge deposits were noted in the river channel. Degradation was observed at ST-09, increasing substanially as the river neared its mouth. Floating meat scraps and grease balls spoiled the appearance of the surface waters and formed large mats of odiferous offal along the banks.

Chemical Observations

Chemical determinations made by the State Geological Survey of Kansas Analytical Laboratory and the Federal Water Pollution Control Administration, found that: the pH values ranged from 7.4 to 8.7; the water temperature reached as high as 32° C; dissolved oxygen deficiencies rarely became a problem; and the total suspended solids varied markedly with the surface runoff.

The chemical characteristics in the river basin most likely to limit the development of a balanced aquatic biota were the large amounts of chlorides, sulfates, sodium, and suspended solids. These parameters

were most often found in limiting values upstream from Junction City, on the Smoky Hill River, especially in the Saline and Solomon Rivers. The Delaware, Republican, and Big Blue Rivers were relatively free of these substances.

Orthophosphate and nitrate nitrogen values were found in concentrations favorable for algal growth throughout the basin. The average concentrations of these nutrients are presented in Table 8. During the spring season there were considerably less algal nutrients than in either the summer or fall.

Benthos

Aquatic invertebrates are used to estimate the condition of the environment in which they are able to live. Certain organisms are more sensitive to environmental changes than others. Pollution-sensitive organisms such as mayflies, caddisflies, and stoneflies are reduced in number or eliminated by degraded water quality conditions. For this reason, it is important to know the specific kinds of organisms which compose the benthic community. Because of this sensitivity and because their life cycles sometimes take over a year to complete, these organisms provide information on past and present water quality conditions. It is beneficial to know the number of organisms per unit area as well as the community composition. Changes in population densities often indicate changes in water quality or food availability.

Great densities of pollution-tolerant organisms such as sludgeworms, coupled with an absence of clean-water forms, often indicate a high degree of organic enrichment. In some areas, polluted conditions will be such as to exclude all forms of life. An example of this type of pollution would be the release of a concentrated industrial waste or toxic material into a water system.

The Kansas River and its tributaries provide a harsh environment for aquatic invertebrates. The benthos must survive numerous seasonal changes in water temperature, flow, turbidity, and chemical quality. Benthic habitats are often destroyed or changed by torrential rains which swell the rivers and scour the channels clean of silt and debris. The shifting sand bottom found in all rivers of this area, offers little in the way of habitat for benthic macroinvertebrates. The benthos can increase in population numbers only along the river banks where silt, clay, and organic debris can accumulate or where rocks have been exposed. Lack of habitat variety limits the number of kinds of organisms, as well as their densities. The available habitat in the river sometimes changed from one location to another, influencing the kind and number of benthic organisms present.

Benthic invertebrates were collected at 64 different locations throughout the river basin. Seventy-eight samples were collected during the spring, summer and fall seasonal surveys; 28 during the reconnaissance studies and 59 during the summer and fall lower Kansas River surveys. A total of 91 different benthic organisms were identified from these samples.

The spring seasonal survey at 21 sampling stations had 34 different kinds of benthic organisms with seven as the average per station. The number of kinds ranged from one at Stations 17 and 20, both below sewage treatment plants, to 11 at Station 50 near Sylvan Grove, Kansas (Table 9).

The mayflies (Ephemeroptera) were found at 76 percent of the spring sampling stations; the stoneflies (Plecoptera) at 67 percent, and the caddisflies (Trichoptera) at 62 percent. Only Station 17, below the Topeka sewage treatment plant lacked a representative from the above pollution sensitive organisms. The pollution-tolerant forms, bloodworms (Tendipedidae) and sludgeworms (Tubificidae), were found at 71 and 62 percent of the sampling sites, respectively. The bloodworms and sludgeworms were common in a variety of aquatic areas in this river basin, including clean water situations.

River reaches with high phytoplankton populations often contained abundant populations of filter feeding organisms. The three invertebrates most commonly encountered were the caddisflies, Hydropsyche sp. and Cheumatopsyche sp., and the black fly (Simuliidae). These organisms were very abundant at Station 50 and were found at over 50 percent of the sampling sites.

During the summer survey, 42 different organisms were found at the sampling stations (Table 10). The average number of kinds per station increased to eight from slightly under seven in the spring survey. Mayflies were found at 79 percent of the sampling stations, caddisflies

at 68 percent, and stoneflies at 47 percent. Bloodworms and sludgeworms were collected at 73 percent of the sampling sites. Of the filter feeders, Hydropsyche sp. was the most common. It was found at 63 percent of the stations.

The fall survey produced the highest average number of kinds per station---ten (Table 11). Caddisfly larvae were present at 75 percent of the fall sampling stations, mayflies at 70 percent, and stoneflies at 20 percent. Bloodworms and sludgeworms were present, respectively, 80 and 70 percent of the time. Physa sp., an air-breathing snail, was found at 50 percent of the stations visited. Hydropsyche sp., the most common organism, was found at nearly 70 percent of the sampling stations.

During the seasonal surveys of the Kansas River, the average number of kinds found at Stations 12, 14, 15, 17, 20, 36, and 37 were reduced to less than half of those commonly found in the upstream areas. Stations 14, 17, and 20 are downstream from the sewage treatment plants of Lawrence, Topeka, and Manhattan, Kansas. The stations on the Republican River, indicate localized areas of degradation. Station 36 collected the backwaters of the Kansas River just below the Manhattan sewage treatment works, and Station 37 was located just downstream from a feed lot and pig farm. Neither station typified the actual water quality conditions below Tuttle Creek Dam and Reservoir.

The benthic community composition was well balanced and indicative of clean water conditions throughout the rest of the primary study area.

The population of benthic organisms was limited by the lack of suitable substrates, however, the predominance of filter feeding organisms indicated that productivity was high. Seasonal variations in the benthic population composition appeared to be the result of natural changes in their life cycles.

A reconnaissance study of both upstream and downstream areas of the Kansas River basin averaged eight kinds of benthic organisms per station (Table 12). This was approximately the same number of kinds found during the seasonal studies of the area below the reservoirs. Mayflies were the most prevalent kind found during this survey. They were at 78 percent of the sampling sites. Caddisfly larvae were found at 53 percent and stonefly nymphs at 10 percent of the station locations. Bloodworms and sludgeworms occurred, respectively, in 72 and 62 percent of the samples. Hydropsyche sp. was the predominant genus of filter feeding organisms, the same as in the seasonal survey.

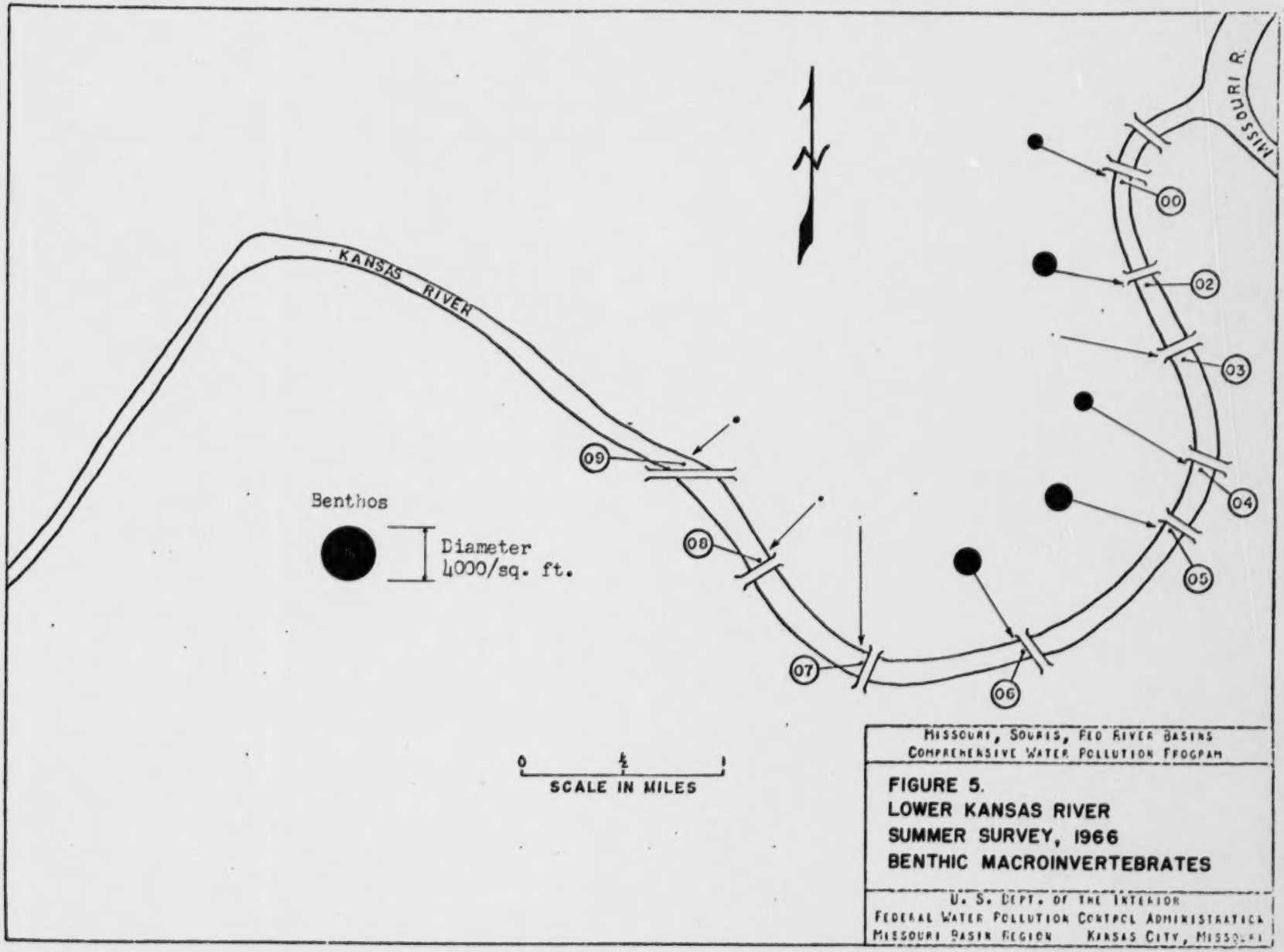
The reconnaissance study showed a significant reduction in the number of kinds of aquatic macroinvertebrates at Stations 00, 01, 11, 22, 38, 51, 55, and 59. Stations 00, 01, and 11 were all located in the lower reaches of the Kansas River in Kansas City, Kansas. Station 22 is located downstream from the Junction City, Kansas sewage treatment works. Station 38, at Blue Rapids, Kansas, reflected the degraded quality of the Big Blue River just before impoundment by the Tuttle Creek Dam. Station 55 and 59 illustrated locally degraded conditions on some of the

smaller tributary streams such as Big Soldier Creek and Wakarusa Creek. Station 51 on the Saline River had a reduction in kinds probably because of high salt concentrations.

During the lower Kansas River studies it was possible to secure quantitative samples at every station. The number of organisms per square foot of bottom averaged 1,035 during the summer (Figure 5). The average number of kinds found was less than two. Only six different benthic organisms were found in this area during the summer (Table 13). Sludgeworms (Tubificidae) comprised 99 percent of the total benthos populations. Station 04-A, had in addition to 3,600 sludgeworms per square foot, 40 sewagefly larvae (Psychodidae), which are tolerant of extremely polluted situations.

The benthic populations found during the fall survey of the lower Kansas River were also dominated by sludgeworms (Table 14). There was an increase in the average number of organisms per square foot in the fall from over 1000 in the summer, to over 5000 in the fall (Figure 6). Although a total of 12 different kinds were found in this area during the fall survey, the variety of organisms at each station averaged less than three kinds.

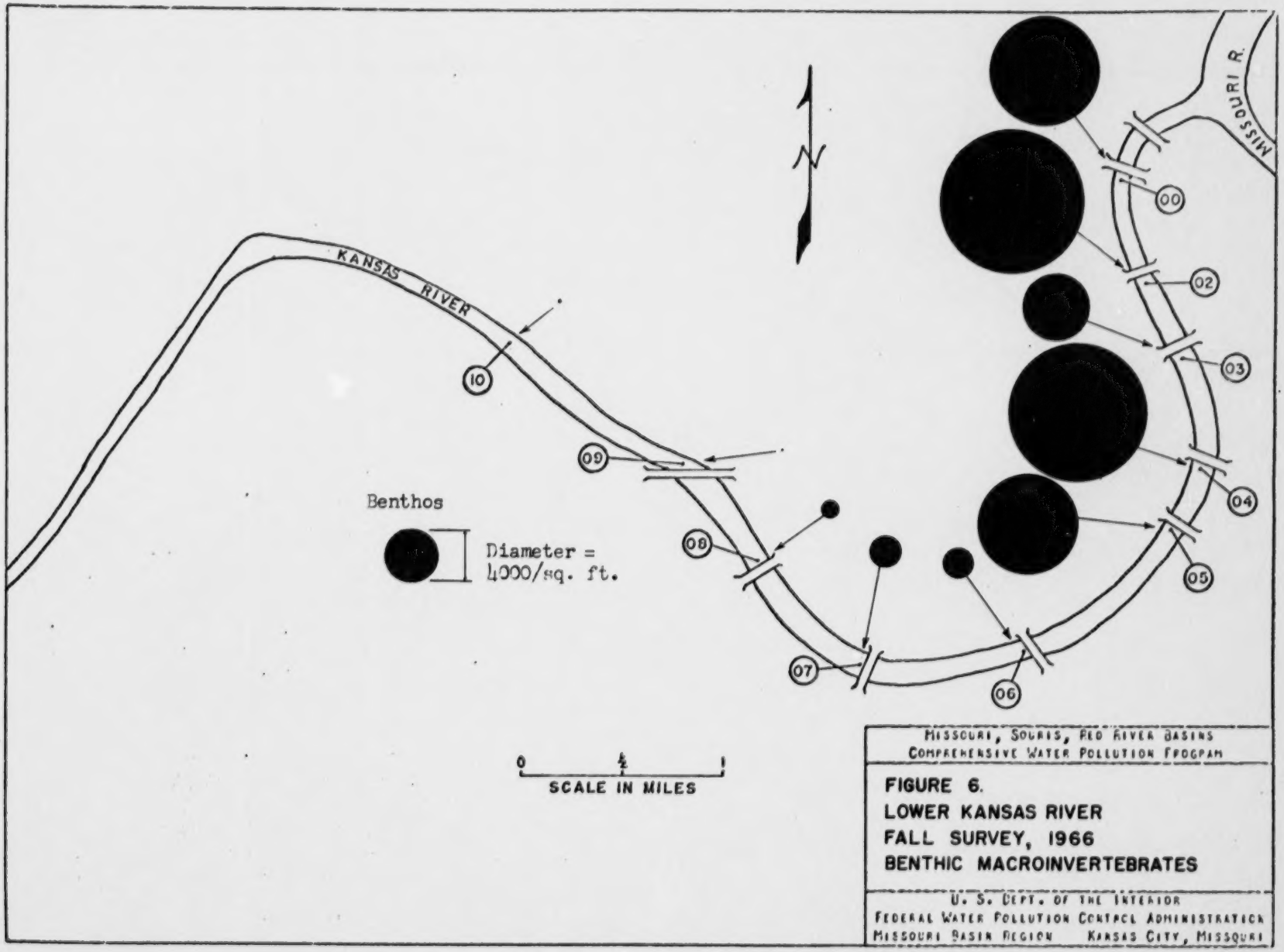
Streamflow velocities were slower in the lower reach of the river because of the increased river depth. The increase in sludgeworm populations in the fall was the result of a continuous build-up of organic materials on the bottom. In comparison, benthos populations were less dense in the summer as a result of the recent scouring and flushing action of the spring rains.



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 5.
LOWER KANSAS RIVER
SUMMER SURVEY, 1966
BENTHIC MACROINVERTEBRATES

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI



Missouri, Souris, Red River Basins
Comprehensive Water Pollution Program

FIGURE 6.
LOWER KANSAS RIVER
FALL SURVEY, 1966
BENTHIC MACROINVERTEBRATES

U. S. Dept. of the Interior
Federal Water Pollution Control Administration
Missouri Basin Region Kansas City, Missouri

All of the station locations downstream from Station 09, River Mile 5.9, were degraded by various industrial wastes. The degree of pollution builds dowrstream from Station 06, River Mile 3.6, where conditions could only be described as grossly polluted.

Although the localized pollution problems in this basin may appear insignificant, they actually can become widespread during periods of minimum river flow. The construction and operation of reservoirs may insure downstream areas of a constant water supply, but limited water supplies that are degraded in upstream areas will probably discourage industry and retard economic growth in these areas.

Phytoplankton

Variations in algal populations often reflect the presence or absence of organic matter in the water. In stream reaches where little or no decomposable material is present, the algae are very limited in number. In reaches that have optimum nutrient conditions, such as in recovery zones downstream from sewage outfalls, large numbers of algae can grow. Industrial wastes on the other hand, may supress algal growths due to the toxic nature of many of these wastes.

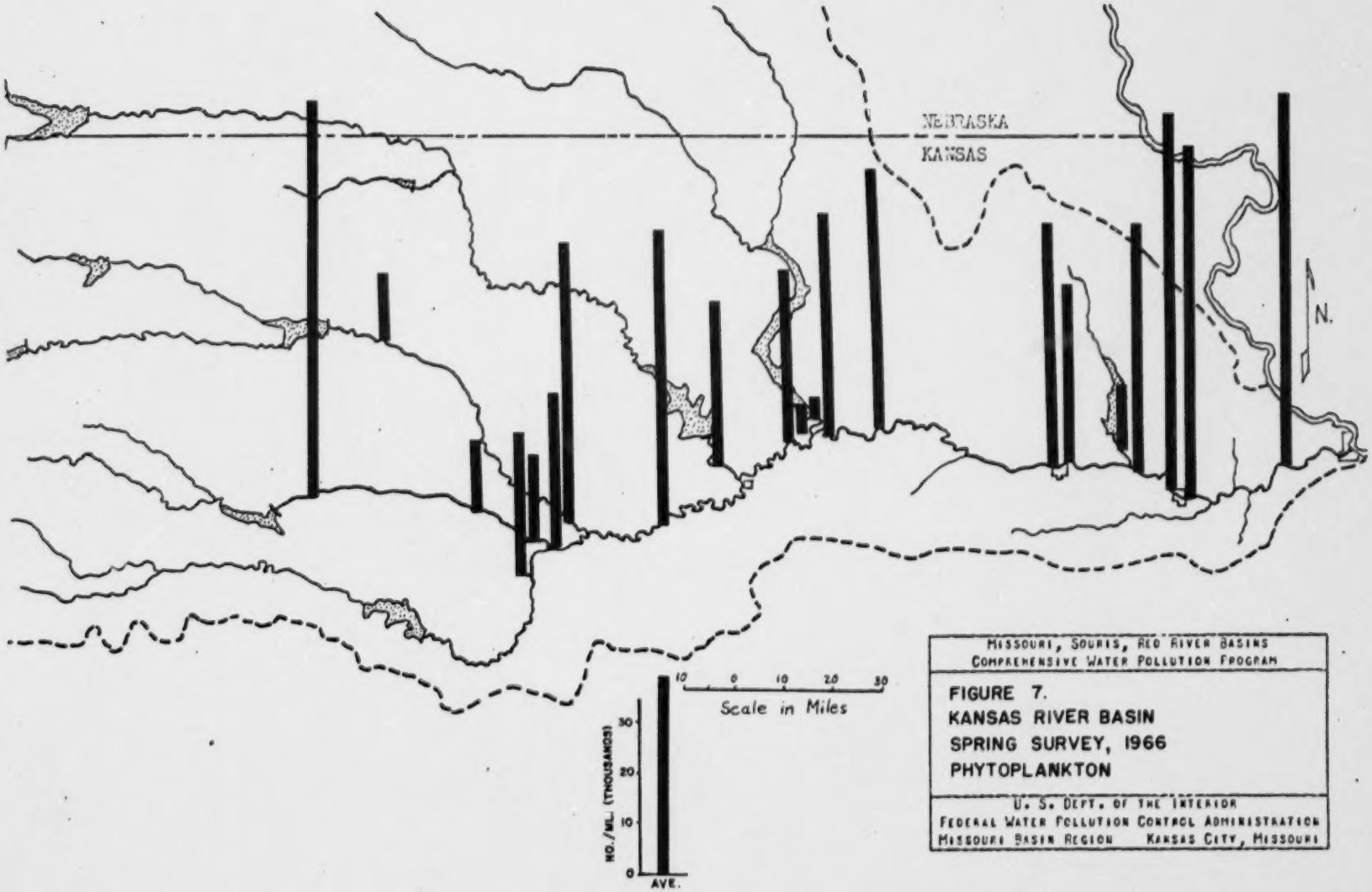
The kinds of algae present often indicate the water quality. Certain species of centric diatoms, flagellates, and blue-green algae, for example, favor highly enriched waters. The predominant phytoplankton genera found during this study are presented in Table 15.

The phytoplankton studies of the Kansas River Basin consisted of three seasonal surveys of the major tributaries and the main stem two surveys of the lower Kansas River in Kansas City, Kansas, and several additional reconnaissance stations located in upstream areas, small tributaries, and the main stem.

Seasonal phytoplankton samples were collected in the Kansas River model area in the spring, summer, and fall of 1966 (Tables 16, 17, 18). A total of 59 population counts were recorded from 21 sampling stations within the model area. The spring survey found very high phytoplankton populations which averaged over 39,000/ml (Figure 7). The summer and fall surveys averaged 10,100/ml and 9,000/ml, respectively (Figures 8 and 9). Nitrate nitrogen and orthophosphate determinations at this time showed the spring concentrations much lower than either the summer or fall (Table 8).

A tiny centric diatom of the Cyclotella-Stephanodiscus group, predominated at all stations during the spring survey and comprised over 80 percent of the total number of algae found. Cyclotella-Stephanodiscus was also predominate at 12 stations sampled during the summer and at 13 in the fall, making up 79 percent of the summer populations and 42 percent of the fall. The blue-green algae were never predominant, and rarely exceeded 600/ml.

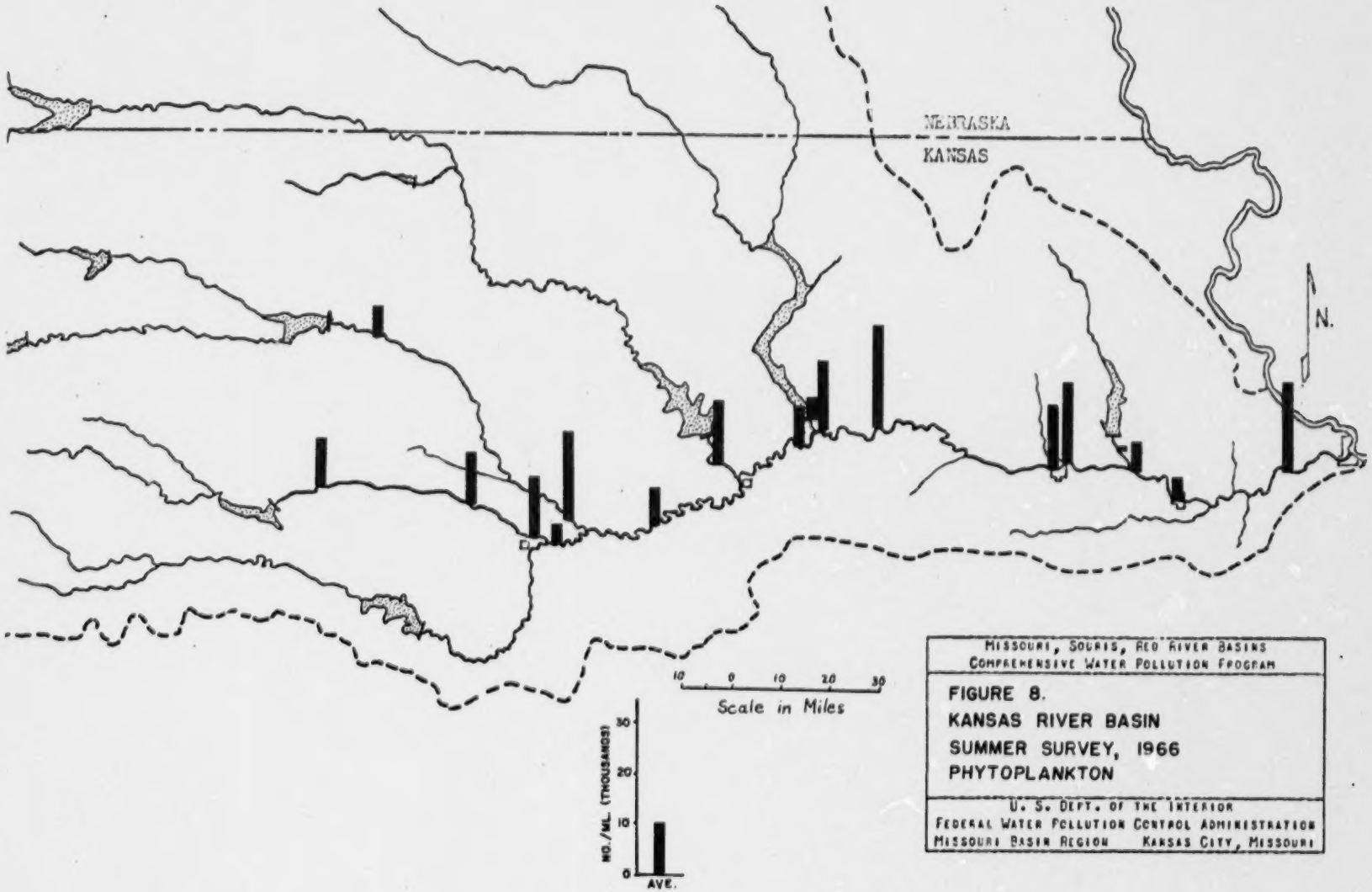
The Kansas River from Manhattan to the mouth exhibited the largest average plankton populations over the seasons. All stations along that reach averaged over 20,000 phytoplankters per milliliter. Station 29 at Wamego, ST-42 on the lower Solomon River and ST-50 below Wilson Reservoir also had an average population of over 20,000/ml. Samples collected



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 7.
KANSAS RIVER BASIN
SPRING SURVEY, 1966
PHYTOPLANKTON

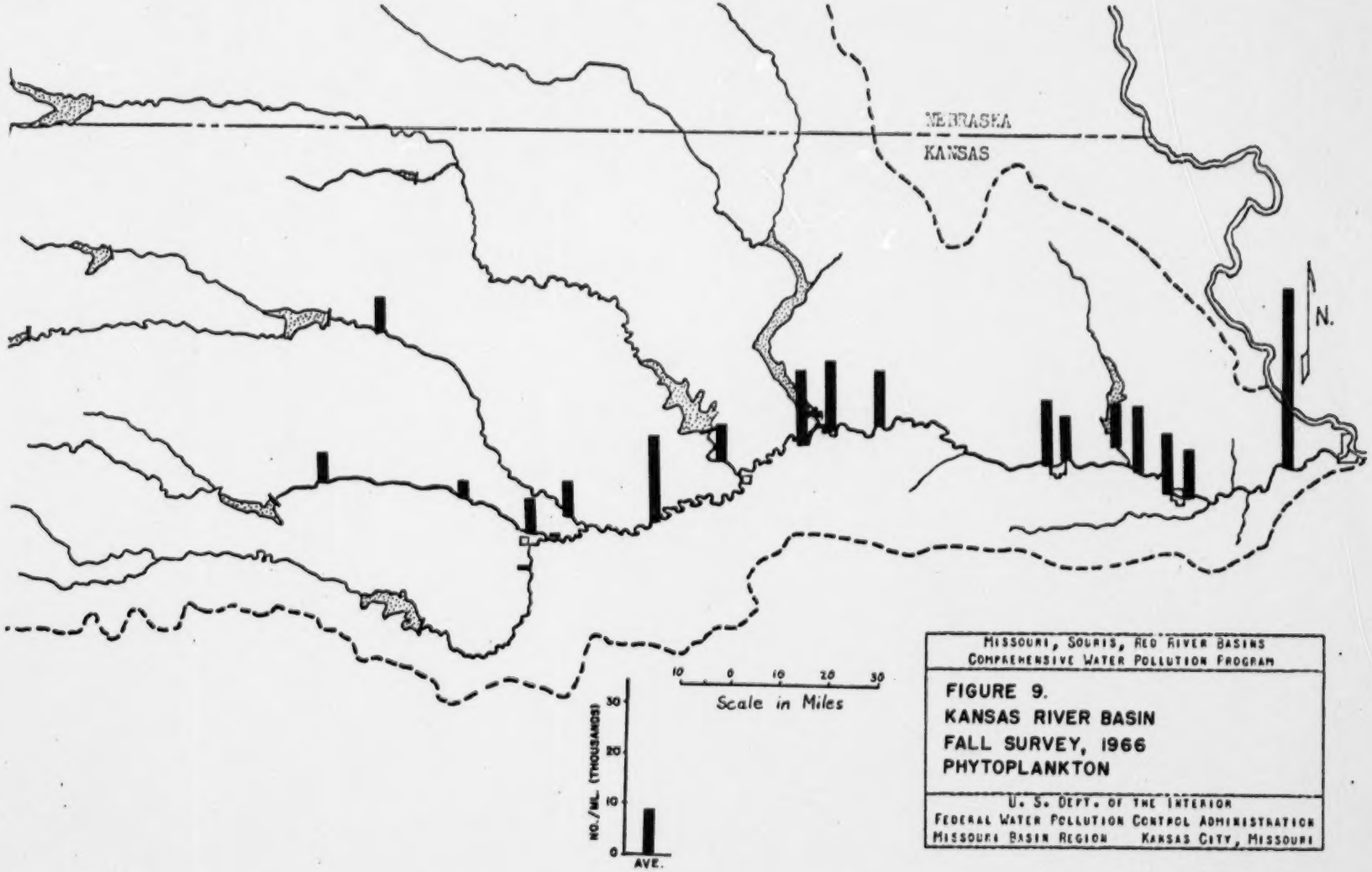
U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 8.
KANSAS RIVER BASIN
SUMMER SURVEY, 1966
PHYTOPLANKTON

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 9.
KANSAS RIVER BASIN
FALL SURVEY, 1966
PHYTOPLANKTON

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI

near the mouths of the Delaware and Big Blue Rivers averaged less than 9,000/ml, the lowest in the study area.

Seasonal phytoplankton sampling illustrated the high productivity of the Kansas River main stem throughout the year, especially in the spring. The large numbers of phytoplankton and the predominance of the centric diatoms indicated the presence of organic wastes and the absence of limiting toxins from industrial wastes. Most of the industrial wastes in this river basin come from food processing industries which dispose of primarily organic wastes. Besides domestic sewage and organic wastes from industry, surface wash was extremely important in adding decomposable nutrients to the rivers. Poor farming practices which allow unchecked drainage of large feeder lots and rapid runoff of fields cause undue contributions of silt and organics to the watercourse.

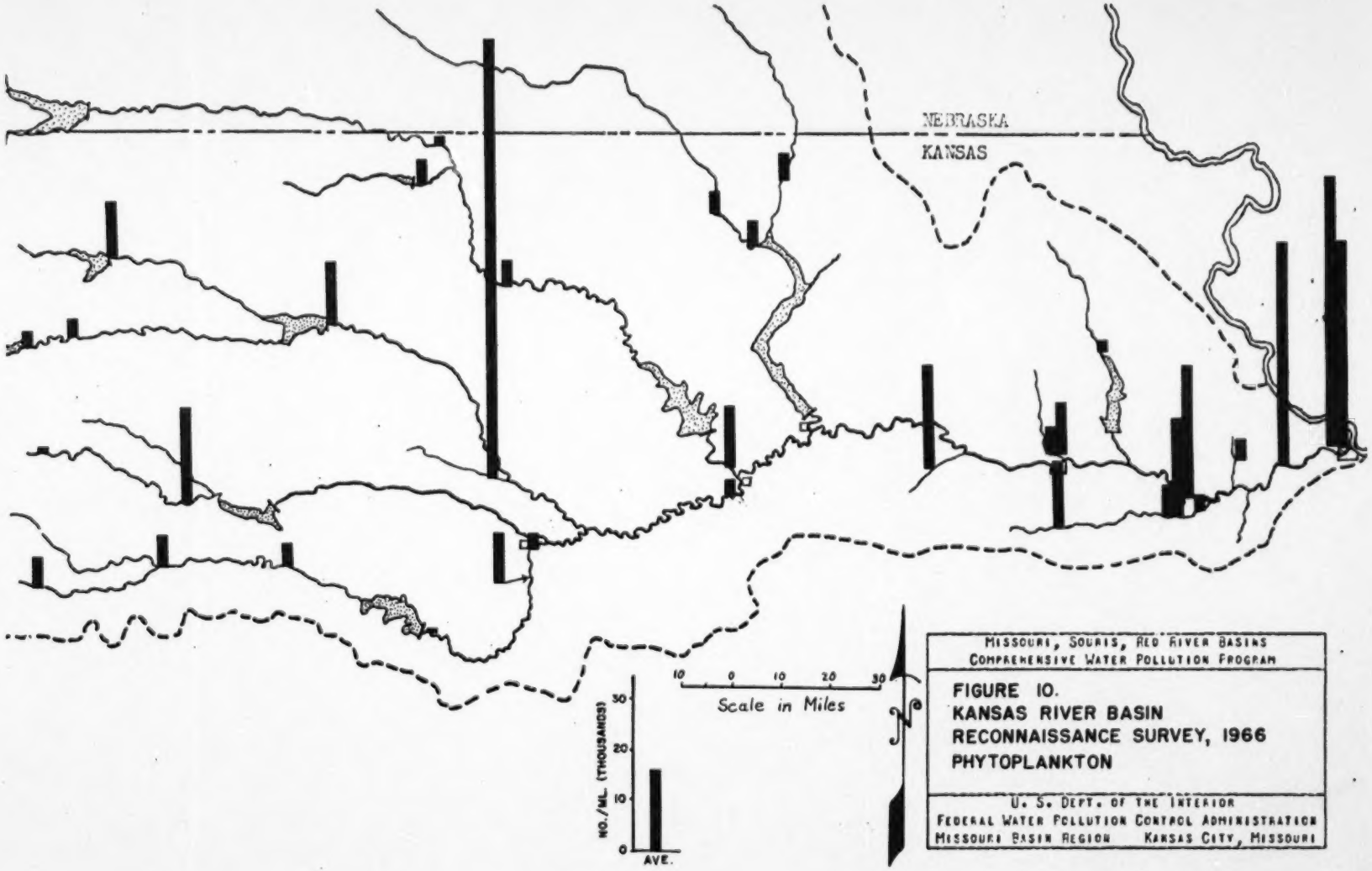
The presence of the salt-tolerant diatoms, Cyclotella nana, C. meneghiniana and Trachelomonas sp. in large numbers indicated the presence of brine either from natural or man induced sources along the Saline River.

A total of 50 phytoplankton counts were made during the reconnaissance surveys (Table 19). This study found an abundance of phytoplankton above the large municipal waste sources as well as below. Agricultural land drainage and feed lot runoffs probably encouraged plankton growth in upstream areas. Extremely abundant populations of Nitzschia palea and Cyclotella nana, salt tolerant diatoms, were found in Salt Creek (ST-75)

where counts reached as high as 86,000/ml. This was probably the result of some local pollution source. Wakarusa and Mill Creeks had high plankton counts - over 20,000/ml (Figure 10). The lower main stem of the Kansas River during this survey also had populations over 20,000/ml, just as it did during the seasonal surveys. The blue-green alga Aphanizomenon flos-aquae was abundant in Kirwin Reservoir (ST-62). This alga can produce tastes and odors in water supplies and dense blooms can result in fish kills and livestock poisoning. It also degrades the recreational value of reservoirs by giving the surface waters an unsightly "pea soup" appearance.

The Kansas River main stem supported over 20,000 phytoplankters per milliliter, but the Kansas River at Kansas City, Kansas, averaged 28,000 to 35,000 phytoplankton organisms per milliliter (Tables 20,21). During both the summer and fall surveys, there was an increase in phytoplankton numbers as you neared the river mouth (Figures 11, 12). Additional organic wastes and a slower flow in this section of the river probably accounted for the dramatic increase in phytoplankton productivity.

Low phytoplankton densities found in the above surveys were most often associated with recent flood conditions which caused increased turbidities and dilution of algal densities. During periods of low or moderate flows the reverse was true, and algal reproduction increased rapidly. The swiftness with which the algae recovered their population numbers indicates that a state of relatively high productivity exists throughout most of the river basin. Average nitrate nitrogen and available phosphate concentrations exceeded those recognized as limiting to



MISSOURI, SOURIS, RED RIVER BASINS
COMPREHENSIVE WATER POLLUTION PROGRAM

FIGURE 10.
KANSAS RIVER BASIN
RECONNAISSANCE SURVEY, 1966
PHYTOPLANKTON

U. S. DEPT. OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
MISSOURI BASIN REGION KANSAS CITY, MISSOURI

FIGURE 11. LOWER KANSAS RIVER, SUMMER SURVEY, 1966, TOTAL PHYTOPLANKTON.

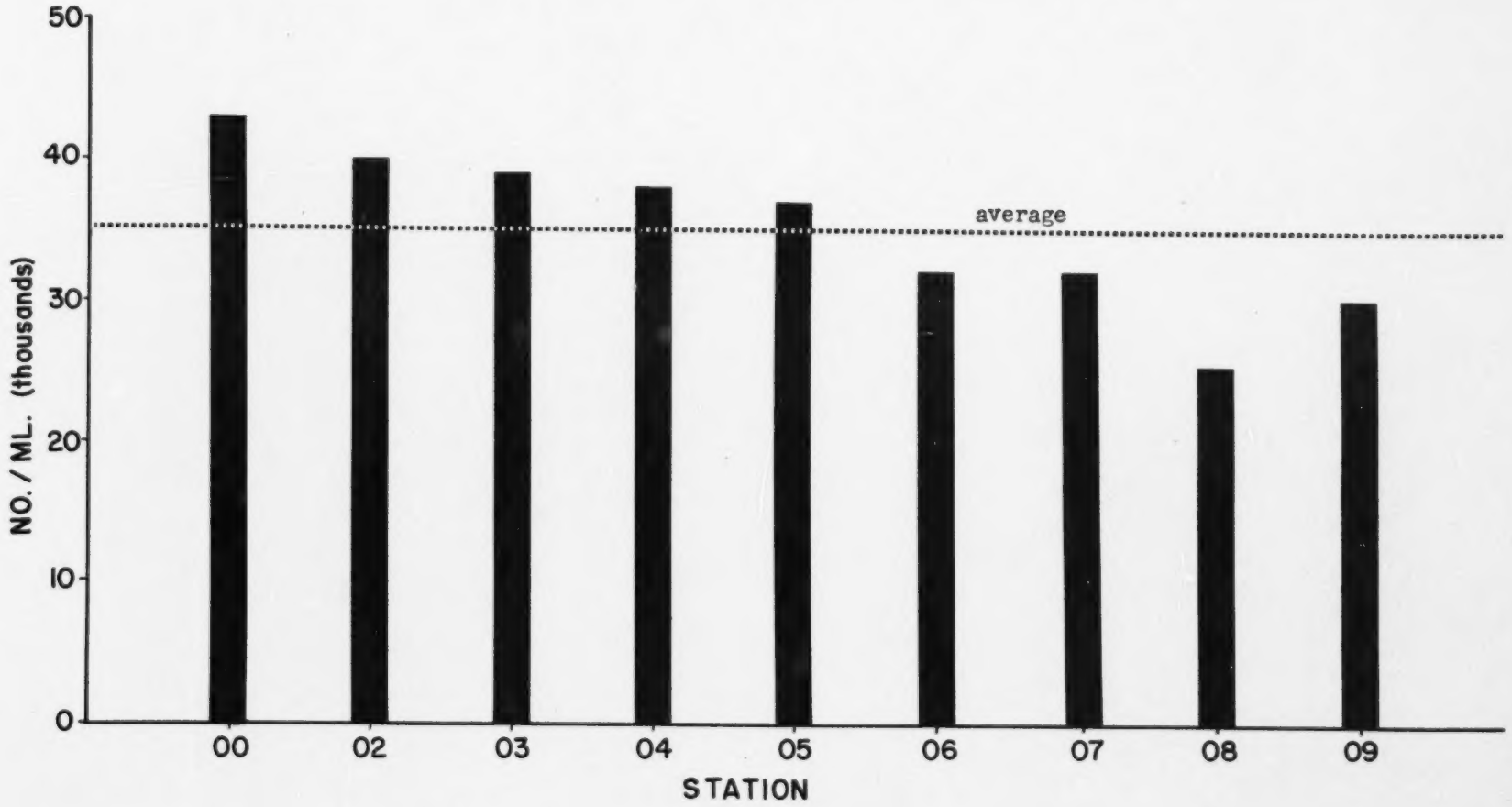
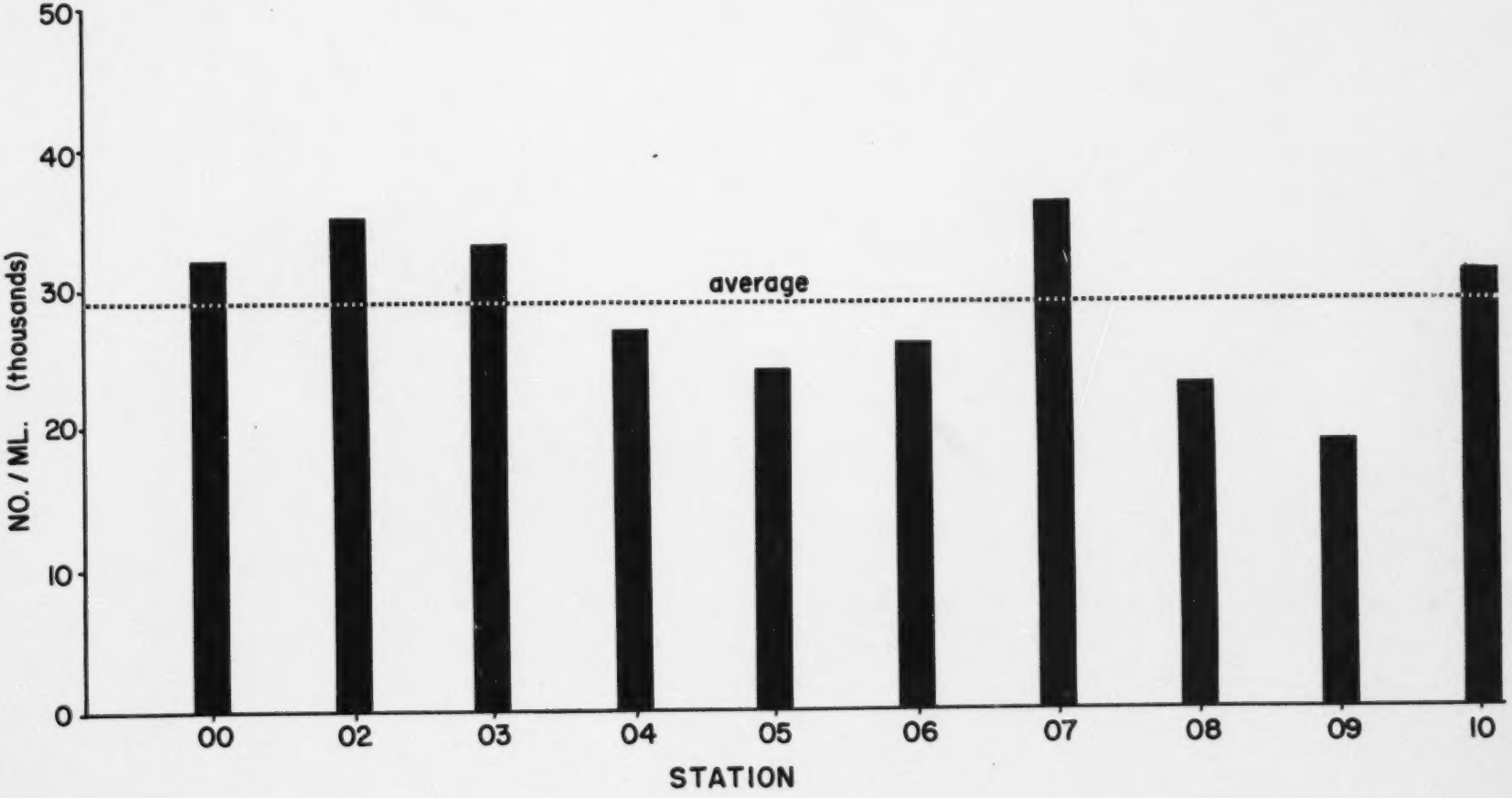


FIGURE 12. LOWER KANSAS RIVER, FALL SURVEY, 1966, TOTAL PHYTOPLANKTON.



algal growth at nearly all stations. The Saline River, which supported a large algal population, showed a surprisingly low soluble phosphate concentration. High turbidities did not seem to limit algal production, except during periods of high water. This was probably due to the shallowness of the rivers during normal flow conditions.

Although discharged sewage is rapidly oxidized in the Kansas River, the organic nutrients are not destroyed, but are converted into plankton algae in downstream areas. The large phytoplankton populations are a nuisance to water supplies in the lower reaches, however, these algae are also beneficial in that they release oxygen to the water and prevent anaerobic conditions from developing in some areas. Evidence of this activity can be seen in the results of dissolved oxygen determinations (8). Where an abundance of algae occurred, supersaturation of dissolved oxygen was also found. At Bonner Springs (ST-72) and Lawrence (ST-15) on the main stem and in Salt Creek (ST-75) the D.O. exceeded 150 percent saturation. Concentrations throughout the river basin were near the saturation point during this study, however, this might suggest that D.O. values at night may be rather low. Large quantities of algae have been known to supersaturate the water during the day and deplete it at night. Only at Station 00, under extremely polluted conditions did the D.O. saturation sag during the day. Here it dipped to only 3 percent saturation, despite the presence of 43,000 phytoplankters.

BIBLIOGRAPHY

1. Academy of Natural Sciences of Philadelphia, Department of Limnology. Kansas River Survey for the Tecumesh Plant of the E. I. du Pont de Nemours and Company, Philadelphia, Pennsylvania, June 1959, pp. 67.

2. Metcalf, Artie L. Fishes of the Kansas River System in Relation to Zoogeography of the Great Plains. University of Kansas Publications, Museum of Natural History, Volume 17, Number 3, University of Kansas, Lawrence, 1966, pp 23-189.

3. U. S. Department of Health, Education and Welfare, Public Health Service, Report on Quality of Interstate Waters, Big Blue River Nebraska-Kansas. Region VI, Kansas City, Missouri, and Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1967, pp. 28.

4. Thomas, Nelson A. Preimpoundment Biological Survey of Wilson Reservoir Kansas. U. S. Department of Health, Education and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1964, pp. 6.

5. Thomas, Nelson A. Postimpoundment Biological Survey of Wilson Reservoir Kansas. U. S. Department of Health, Education and Welfare, Federal Water Pollution Control Administration, Technical Services Program, Cincinnati, Ohio, 1965, pp. 5.

6. Thomas, Nelson A. Postimpoundment Biological Survey of Tuttle Creek Reservoir - Kansas, August 1965. U. S. Department of Health, Education and Welfare, Federal Water Pollution Control Administration, Technical Services Program, Cincinnati, Ohio, 1965, pp 3.

7. Thomas, Nelson A. Biological Survey of Tuttle Creek Reservoir - Kansas, August 1966. Technical Advisory and Investigations Activities, Federal Water Pollution Control Administration, U. S. Department of the Interior, Cincinnati, Ohio, pp 5.

8. O'Brien, Walter J. and Ernest E. Angino, Chemical Water Quality of the Lower Kansas River Basin. Prepared under Contract PH 86-66-63 with the Federal Water Pollution Control Administration, Missouri-Souris-Red River Basins Comprehensive Water Pollution Control Project, University of Kansas Center for Research, Inc., Engineering Science Division, Lawrence, Kansas, November, 1966, pp. 70.

9. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Standard Methods for the Examination of Water and Waste Water, Including Bottom Sediment, and Sludges, 12th Edition, American Public Health Association Inc., 1790 Broadway, New York, New York, 1965, pp. 769.

APPENDIX

Table 1

Kansas River Basin
Sampling Station Location Guide

Station No.	STORET No.	River Mile	U. of K. Model St.	Description
00	190100	0.6	1	Kansas River, James Street Bridge, Kansas City
01	190101	0.9		Kansas River, K.C.S.R.R. Bridge, Kansas City
02	190102	1.3		Kansas River, Central Avenue Bridge, Kansas City
03	190103	1.6		Kansas River, U.P.R.R. Bridge, Kansas City
04	190104	2.2		Kansas River, E. Kansas Ave. Bridge, Kansas City
05	190105	2.6		Kansas River, K.C.R.R. Bridge, Kansas City
06	190106	3.6		Kansas River, 7th Street Bridge, Kansas City
07	190107	4.4		Kansas River, 12th Street Bridge, Kansas City
08	190108	5.2		Kansas River, 18th Street Bridge, Kansas City
09	190109	5.9		Kansas River, W. Kansas Ave. Bridge, Kansas City
10	190110	6.9		Kansas River, 41st and Speaker Street, Kansas City
11	190111	9.3		Kansas River, Turner Bridge, Hwy. 132
12	190112	20.2		Kansas River, Old Bridge Site in Bonner Springs
13	190113	28.9		Kansas River, 1 Mile E. of DeSoto, 1 Mile North of Cedar Junction
14	190114	47.4		Kansas River, 3 Miles E. of Lawrence, 1 Mile North of Kaw Valley School
15	190115	51.3	4	Kansas River, Lawrence Spillway, U.S. 59 Bridge, Lawrence
16	190116	63.5	5	Kansas River, ½ Mile N. of Lecompton on FAS 330
17	190117	80.4		Kansas River, Chester Avenue, Topeka, below STP
18	190118	82.1	7	Kansas River, Sardou Bridge, Topeka
19	190119	125.7	8	Kansas River, Hwy. K-99 Bridge, Wamego
20	190120	146.0		Kansas River, 100 Yds. Downstream from STP, Manhattan

Sampling Station Location Guide - Kansas River

Station No.	STORET No.	River Mile	U. of K. Model St.	Description
21	190121	146.8	10	Kansas River, K-177 (K-10) Bridge, Manhattan
22	190122	160.9		Republican River, Hwy. 18 Bridge, Junction City
23	190123	174.8	11	Republican River, US-77 Bridge, 2 Miles Downstream from Milford Dam
24	190124	207.0		Republican River, Hwy. 15 Bridge, Clay Center
25	190125	266.2		Republican River, Hwy. 81, 1 Mile North of Concordia
26	190126	301.0		Republican River, 2 Miles West of Republic
27	190127	168.8-2.3	12	Smoky Hill River, K-57 Bridge, (US Alternate 40) Junction City
28	190128	32.5		Kansas River, Sunflower Ord. Intake, DeSoto
29	190129	168.8-45.1	13	Smoky Hill River, Hwy. 43 Bridge, Enterprise
30	190130	168.8-93.7	14	Smoky Hill River, New Bridge Site, 2½ Miles SW of New Cambria, 1 Mile W. of FAS 595
31	190131	168.8-102.1		Smoky Hill River, 50 Yds. Downstream from STP, Salina
32	190132	168.8-125.1		Smoky Hill River, 1 Mile East of Mentor
33	190133	168.8-242.3		Smoky Hill River, South of Wilson, Co. Rd. 232
34	190134	168.8-271.6		Smoky Hill River, Hwy. 281, 7.7 Miles S. of Russell
35	190135	168.8-309.7		Smoky Hill River, Hwy. 183, 8 Miles S. of Hays
36	190136	144.7-1.0		Big Blue River, Hwy. 24 Bridge, Manhattan
37	190137	144.7-7.5	9	Big Blue River, Casement Road Bridge, 2.4 Miles Downstream from Tuttle Creek Dam
38	190138	144.7-58.3		Big Blue River, Hwy. 77 Bridge, Blue Rapids
39	190139	144.7-79.4		Big Blue River, Hwy. 36 Bridge at Marysville
40	190140	64.1-1.6	6	Delaware River, K-24 Bridge, West of Perry
41	190141	64.1-24.0	Also Used	Delaware River, 0.2 Mile N. of Valley Falls
42	190142	168.8-64.8-20.9	16	Solomon River, 0.8 Mile W. of Niles on FAS 1050

Sampling Station Location Guide - Kansas River

Station No.	STORET No.	River Mile	U. of K. Model St.	Description
43	190143	168.8-64.8-137.1		Solomon River, Farm 2 Miles SE of Beloit
44	190144	168.8-64.8-138.8	Also Used	Solomon River, Hwy. 14 South of Beloit
45	190145	168.8-64.8-253.1		Solomon River, Hwy. 183 South of Stockton
46	190146	168.8-64.8-179.6-79.0		Solomon River, North Fork, Hwy. 183 at Glade
47	190147	168.8-88.2-3.0	15	Saline River, ½ Mile South of New Cambria
48	190148	168.8-88.2-62.4	19	Saline River, ½ Mile South of Tescott on FAS 447
49	190149	168.8-88.2-71.9		Saline River, 3.5 Miles Upstream from Tescott
50	190150	168.8-88.2-122.7	20	Saline River, Hwy. 181 Bridge, Sylvan Grove
51	190151	168.8-88.2-166.1		Saline River, Hwy. 281, 5 Miles N. of Russell
52	190152	168.8-88.2-219.2		Saline River, Hwy. 183, N. of Hays
53	190153	34.0-1.0		Stranger Creek, Hwy. 32, E. of Linwood
54	190154	34.0-18.7		Stranger Creek, Hwy. 24, E. of Tonganoxie
55	190155	41.6-2.1		Wakarusa Creek, K-10 W. of Eudora
56	190156	41.6-15.4		Wakarusa Creek, Hwy. 59 Bridge, S. of Lawrence
57	190157	41.6-59.6		Wakarusa Creek, Hwy. 75 Bridge, S. of Topeka
58	190158	30.3-0.2		Kill Creek, K-10 Bridge, DeSoto
59	190159	79.6-2.6		Big Soldier Creek Cut-Off, Hwy. 75 Bridge, North Topeka
60	190160	79.6-4.1		Big Soldier Creek Cut-Off, C.R.I. and P.R.R. Bridge below Outfall
61	190161	168.8-276.5-41.1		Big Creek, 3 Miles SE of Hays
62	190162	168.8-64.8-65.3		Kirwin Reservoir near Outlet, Kirwin
63	190163	300.9-17.5		White Rock Creek, 2nd Bridge Downstream from Lovewell Dam
64	190164	144.7-34.5		Fancy Creek-Tuttle Creek Reservoir, Hwy. 77, Randolph
65	190165	168.8-64.8-265.5		Webster Reservoir near Outlet, W. of Stockton

Sampling Station Location Guide - Kansas River

Station No.	STORET No.	River Mile	U. of K. Model St.	Description
66	190166	168.8-88.2-159.6-63.6		Paradise Creek, Hwy. 183, S. of Plainville
67	190167	168.8-64.8-179.6-67.2-11.5		Bow Creek, Hwy. 183, N. of Stockton
68	190168	168.8-88.2-159.6-10.5		Paradise Creek, Hwy. 281, 11 Miles N. of Russell
69	190169	103.1-24.0		Mill Creek, I-70 Near Paxico
70	190170	144.7-61.7-17.6		Little Blue River, Hwy. 15E, 4.5 Miles North of Barnes
71	190171	79.6-4.2		Big Soldier Creek Cut-Off, C.R.I. and P.R.R. Bridge - Above Outfall
72	190172	19.3	2	Kansas River, at Hwy. K-7 Bridge, ½ Mile E. of Bonner Springs, Wyandotte Co.
73	190173	41.6-0.7	3	Wakarusa River at Co. Rd. Bridge on FAS 200, ½ Mile N. of Eudora, Douglas Co.
74	190174	168.8-117.0	21	Smoky Hill at Magnolia Rd. Bridge, 4.0 Miles N. of Mentor, Saline County
75	190175	168.8-64.8-51.4-9.2	17	Salt Creek, Hwy. K-106 Bridge, 1.5 Miles S. of Minneapolis
76	190176	168.8-64.8.164.2	18	Solomon River at Co. Rd. FAS 466, Glen Elder
77	190177	168.8-194.4	22	Smoky Hill at Co. Rd. Bridge 0.5 Miles Downstream from Kanopolis Dam, 5 Miles N. of Langley, Ellsworth Co.

Table 2

Kansas River Survey
Spring Survey, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
12	-	Silt, sand, rubble	-	Water odor - normal; bottom odor - oil; estimated water quality - moderately degraded; water - turbid and moderate in flow. Cladophora present.
14	-	Clay, silt, sand	-	Water odor - normal; bottom odor - sewage; slime present.
15	-	Clay-ooze	-	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid and moderate in flow; Cladophora on spillway.
16	-	Clay, silt, sand	-	Water and bottom odor - normal; estimated water quality - clean; water - turbid and beige.
17	-	Silt, sand	1.0	Water and bottom odor - sewage; estimated water quality - polluted; water - beige and moderate in flow; slime present.
18	-	Silt, sand, rubble	1.5	Water and bottom odor - normal; estimated water quality - clean; water - turbid and moderate in flow.
19	2	Silt, sand, rock	0.5	Water and bottom odor - normal; estimated water quality - perhaps late recovery; water - turbid and green-brown.
20	-	-	1.0	Water - turbid, beige and moderate in flow. Some slime; water and bottom odor - sewage.

Kansas River - Spring Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
21	1.0	Clay, sand, rock	2.0	Water and bottom odor - normal; estimated water quality - clean; water - green-brown and moderate in flow.
23	5	Sand, rock, gravel	2.0	Water and bottom odor - normal; estimated water quality - clean; fungus present.
29	4	Gravel, rubble	1.5	Water and bottom odor - normal; estimated water quality - clean; water - swift.
30	2	Silt, sand	To Bottom	Water and bottom odor - normal; water - swift.
32	2	Silt, sand	-	Water and bottom odor - normal; estimated water quality - clean; water - clear and swift.
36	3		-	Estimated water quality - fairly clean; water - light green and stagnant.
37	-	Silt, sand, rubble	-	Water and bottom odor - sewage; estimated water quality - moderately degraded; water - green and slow; slime present.
40	-	Clay, silt	-	Water and bottom odor - normal; water - moderate in flow; Cladophora present.
42	-	Clay, silt	-	Water - green-brown and moderate in flow.

Kansas River - Spring Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
44	3	Silt	2.5	Water and bottom odor - normal; estimated water quality - clean; water - turbid; some slime present.
47	2	-	-	Water and bottom odor - normal; water - brown and moderate in flow; Spirogyra present.
48	2	Clay, silt, sludge	-	Water odor - normal; estimated water quality - moderately degraded; water - turbid, green-brown and moderate in flow; slime present.
50	1	Silt, sand, rock	-	Water and bottom odor - normal; estimated water quality - moderately degraded; water - turbid, green and moderate in flow.

Table 3

Kansas River Survey
Summer Survey, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
12	-	Silt, rock, sand	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid, brown and slow in flow.
15	-	Silt, sand	-	Water odor - industrial waste; water - turbid and beige.
16	3	Silt, sand	0.2	Water and bottom odor - normal; estimated water quality - clean; water - turbid and beige.
17	-	Silt, sand	0.3	Water and bottom odor - sewage; estimated water quality - degraded; water - turbid, brown and moderate in flow.
18	-	Silt, sand	0.3	Water and bottom odor - industrial waste; estimated water quality - moderately degraded; water - turbid, beige and moderate in flow.
19	5	Silt, sand, rubble	0.3	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid, brown and moderate in flow.
20	5	Silt, sand	0.3	Water odor - normal; bottom odor - sewage; estimated water quality - moderately degraded; water - turbid and moderate in flow; slime and Cladophora present.

Kansas River - Summer Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
21	2	Silt, sand	0.3	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid and moderate in flow; some green algae on bottom sand.
23	5	Silt, sand, rubble	0.5	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid, beige and moderate in flow.
27	5	Silt, sand, rock	0.3	Water and bottom odor - normal; estimated water quality - clean; water - turbid, beige and moderate in flow.
29	4	Sand, rock	0.2	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid, brown and moderate in flow.
30	6	Silt, sand	0.3	Water and bottom odor - normal; estimated water quality - clean; water - turbid, beige and swift.
32	6	Silt, sand	0.1	Water and bottom odor - normal; water - turbid, brown and swift.
36	3	Silt, sand	1.2	Water and bottom odor - normal; estimated water quality - moderately degraded; water - green-brown, slow to stagnate.
40	5	Silt	0.5	Water odor - sewage; bottom odor - normal; water - turbid and brown.

Kansas River - Summer Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
42	3	Silt, sand	0.3	Water and bottom odor - normal, estimated water quality - clean; water - turbid and moderate in flow
43	4	Silt, sand	0.2	Water odor - normal; bottom odor - sewage; estimated water quality - fairly clean to slightly degraded; water - turbid, brown and moderate in flow
47	4	Silt, sand	0.2	Water and bottom odor - normal; estimated water quality - clean; water - turbid and beige.
49	3	Ooze, silt	0.2	Water and bottom odor - normal; estimated water quality - fairly clean; water - beige and slow moving.
50	1	Silt, sand	1.0	Water and bottom odor - normal; estimated water quality - moderately degraded; water - turbid and slow; Cladophora present.

35

Table 4

Kansas River Survey
Fall Survey, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
12	-	Silt, rubble	-	Water and bottom odor - normal; estimated water quality - moderately degraded; water - turbid.
14	-	Silt, sand	0.7	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid.
15	-	Silt, sand, rock	0.9	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid; Cladophora present; many dead shad present.
16	-	Silt, sand	0.5	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid.
17	-	Silt, sand	0.5	Water and bottom odor - normal; estimated water quality - moderately degraded; water - turbid and moderate in flow.
18	-	Silt, sand	0.5	Water and bottom odor - normal; estimated water quality - moderately degraded; water - turbid and moderate in flow.
19	-	Silt, rock	0.7	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid.
20	-	Silt, sand	0.6	Water and bottom odor - sewage; estimated water quality - polluted; water - turbid and moderate in flow; several dead shad floating in water; Sphaerotilus present.

Kansas River - Fall Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
21	-	Sand, gravel	0.7	Water and bottom odor - normal; estimated water quality - clean; water - moderate.
22	-	Silt, sand, rock	-	Water odor - normal; bottom odor - sewage.
23	2	Sand	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - clear and swift.
29	-	Ooze, silt, rock	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - clean and moderate in flow; Cladophora on rocks; benthic algae also present.
30	1	Sand, gravel	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - clean and moderate in flow; some Cladophora present.
32	2	Sand, gravel	2.0	Water and bottom odor - normal; estimated water quality - clean; water - clear.
37	3	Sand, gravel	0.1	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid and swift.
40	-	Silt, rock	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - turbid and slow moving
42	3	Silt, sand	1.0	Water and bottom odor - normal; estimated water quality - fairly clean; water - clear and moderate in flow.

Kansas River - Fall Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
43	2	Rubble, rock detritus	1.5	Water and bottom odor - sewage; estimated water quality - moderately degraded; water - fairly clear and moderate in flow.
47	1	Sand, gravel	1	Water and bottom odor - normal.
48	2	Gravel, rubble detritus	1.0	Water and bottom odor - normal; estimated water quality - moderately degraded; water - clear.
50	1	Rubble, rock detritus	1.0	Water and bottom odor - normal; estimated water quality - moderately degraded; water - clear and moderate in flow; much Cladophora and slime present.

Table 5

Kansas River Survey
Reconnaissance Study, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
00	-	Silt	-	Hair, grease, blood, offal, meat pieces and manure present.
01	-	Silt	-	Grease, tripe, hair, and fat present, estimated water quality-septic.
09	-	Silt	-	Bottom oily.
15	-	Silt & Sand	-	Water and bottom odor-normal, estimated water quality-fairly clean, water-green-brown, abundance of Cladophora.
22	-	Silt, Sand Rock	-	Water odor-normal, bottom odor-sewage, slime on rocks.
24	4	Silt & Sand	-	Water and bottom odor-normal, estimated water quality--clean, water-turbid, beige, and moderate in flow.
25	3	Silt & Sand	-	Water and bottom odor-normal, estimated water quality-clean, water turbid, beige, and swift in flow.
26	4	Silt & Sand	-	Water and bottom odor-normal, estimated water quality-fairly clean, water-turbid, beige and swift.

Kansas River - Reconnaissance Study

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
31	5	Silt, Sand & Rock	-	Water and bottom odor-sewage, estimated water quality-fairly clean to moderately degraded, water turbid, beige and moderate in flow.
33	3	Silt, Sand & Gravel	0.2	Water and bottom odor-normal, estimated water quality-clean, water-turbid, beige and swift.
34	3	Silt & Sand & Gravel	-	Water and bottom odor-normal, estimated water quality-fairly clean to moderately degraded, water-turbid, beige, and moderate in flow.
35	2	Silt, Sand & Gravel	-	Water and bottom odor-normal, estimated water quality-fairly clean, water-clear and moderate in flow, Cladophora present.
38	-	Silt	-	Water and bottom odor-normal, estimated water quality-moderately degraded, water-turbid, brown and moderate in flow.
39	4	Silt & Sand	-	Water and bottom odor-normal, estimated water quality-moderate degraded, water turbid, brown and moderate in flow.
41	3	Silt & Gravel	-	Water and bottom odor-normal, estimated water quality-moderately degraded, water-turbid and beige in color, some benthic periphyton.

Kansas River - Reconnaissance Study

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
45	2	Sand	-	Water and bottom odor-normal, estimated water quality-clean, water-clear and swift, Lemna and Cladophora present.
51	2	Silt, Sand & Gravel	-	Water and bottom odor-normal, estimated water quality-fairly clean, water clear and moderate in flow.
52	1	Sand	-	Water and bottom odor-normal, estimated water quality-clean, water-clear and slow.
54	4	Silt	-	Water and bottom odor-normal, estimated water quality-moderately degraded, water-turbid, brown, and slow moving.
55 (4-4-66)	-	Silt	-	Water and bottom odor-normal, water-turbid and green.
55 (7-25-66)	3	Silt	-	Water and bottom odor-algae, estimated water quality-polluted, water-stagnant, green and with a plankton bloom.
57 (6-16-66)	-	Clay & Silt	0.3	Water and bottom odor-normal, estimated water quality as fairly clean, water green-brown and slightly stagnant.
57 (7-25-66)	4	Gravel & Silt	-	Water and bottom odor-normal, estimated water quality-moderately degraded, water-turbid, green, and stagnant, large plankton bloom.
58 (7-25-66)	1	Silt, Gravel Rock	1.0	Water odor-algae, bottom odor-industrial waste-estimated water quality as moderately degraded, water-clear.

Kansas River - Reconnaissance Study

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
58 (Cont'd)				green-brown, and moderate in flow, benthic algae covering the bottom.
58 (11-3-66)	2	Silt & Rock	1.5	Water and bottom odor-normal, estimated water quality-moderately degraded, water clear to slightly brown, bottom leaves were brown.
59 (6-17-66)	2	Silt & Sand	-	Water and bottom odor-oil, estimated water quality-fairly clean, flow-moderate.
59 (11-2-66)	1	Silt & Sand	1	Water odor-normal, bottom odor-industrial waste, estimated water quality-polluted, water slow, benthic algae completely covering the bottom-black ooze underneath, sewage fungus present.
63	1	Clay & Silt	-	Water, bottom odor-normal, estimated water quality-moderately degraded, water-turbid, brown and moderate in flow.
69	3	Silt, Sand & Rock	1.0	Water and bottom odor-normal, estimated water quality-fairly clean, water-green-brown in color.
70	2	Silt & Sand	0.1	Water and bottom odor-normal, estimated water quality-fairly clean, water-turbid, beige, and moderate in flow.
71	1	Silt & Sand	1	Water and bottom odor-normal, estimated water quality-clean, water-clean and slow, some Spirogyra present.

Table 6

Lower Kansas River
Summer Survey, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
00	28	Silt	1.3	Water odor-sewage, bottom odor-sewage, estimated water quality-polluted, water-brown and slow moving.
02	10	Silt	1.2	Water odor-sewage, bottom odor-sewage, estimated water quality-polluted, water-turbid and brown and slow moving, blood, grease, hair, and offal in water.
03	10	Silt	1.5	Water odor-sewage, bottom odor-sewage, estimated water quality-polluted, water-turbid, grease, sludge, and hair in water.
04	10	Silt	1.7	Water odor-sewage, bottom odor-sewage, estimated water quality-polluted, water-turbid, brown and slow moving-a wide variety of meat packing wastes present.
05	12	Silt	1.7	Water odor-sewage, bottom odor-sewage, water-turbid, brown, and slow moving, reduction in refuse floating on surface.
06	8	Silt	1.5	Water odor-normal, bottom odor-normal, estimated water quality-polluted, water-turbid, brown, and slow.

Lower Kansas River - Summer Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
07	10	Silt & Sand	1.0	Water odor and bottom odor-industrial waste, estimated water quality-polluted, water-green-brown and slow moving, dead carp and gar present.
08	06	Silt,Sand & Gravel	0.5	Water odor and bottom odor-oil and industrial waste, estimated water quality-polluted, water-turbid and slow moving.
09	10	Silt & Gravel	0.8	Water and bottom odor-industrial waste, estimated water quality-polluted, water-turbid, green-brown and slow, oil on water and bottom.
11	-	Silt	1.0	Water and bottom odor-sewage, estimated water quality-fairly clean, water-turbid, brown and slow.

Table 7

Lower Kansas River Survey
Fall Survey, 1966
Physical Observations

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
00	18	Silt	0.8	Water and bottom odor-sewage, estimated water quality-polluted, water-turbid, green-brown and slow, meat, hair and flesh present.
02	15	Silt	0.6	Water and bottom odor-sewage, estimated water quality-polluted, water-turbid and green-brown, much slime and hair.
03	12	Silt & Sludge	0.5	Water and bottom odor-sewage, estimated water quality-polluted, water color-green-brown, much plant material in the samples.
04	-	Silt & Sludge	0.5	Water and bottom odor-sewage, estimated water quality-polluted, water-turbid, green-brown and slow moving.
05	12	Silt & Sludge	0.5	Water and bottom odor-sewage, estimated water quality-polluted, water-turbid and green-brown, grease and leaves present.
06	10	Silt & Sludge	0.5	Water and bottom odor-sewage, estimated water quality-polluted, water color-green-brown, slight plankton bloom present.
07	12	Silt	0.5	Water and bottom odor-oil and industrial waste, estimated water quality-polluted, water-beige in color and moderate in flow, Cladophora present.

Lower Kansas River - Fall Survey

Station No.	Depth in Feet	Bottom Type	Secchi Disc-Ft.	Notes
08	5	Silt, Sand & Gravel	0.5	Water and bottom odor-industrial waste and oil, estimated water quality-polluted, water-beige in color and moderate in flow, oil on water surface and also on left bank.
09	5	Silt	0.4	Water odor-normal, bottom odor-industrial waste, estimated water quality as moderately degraded, Cladophora present.
10	5	Silt,Sand & Gravel	0.4	Water and bottom odor-normal, estimated water quality clean, water-turbid and beige.

Table 8

Kansas River Basin

Average Chemical Values, 1966

mg/l

Station Number	Spring		Summer		Fall	
	NO_3-N	Sol.-P	NO_3-N	Sol.-P	NO_3-N	Sol.-P
00	-	-	3.5	1.40	-	-
15	0.1	0.21	2.8	0.37	2.4	0.17
16	0.1	0.27	2.9	0.29	-	-
18	0.15	0.20	2.6	0.29	2.3	0.17
19	0.25	0.20	2.6	0.30	2.8	0.20
21	0.2	0.17	2.8	0.37	1.9	0.28
23	0.4	0.25	2.8	0.38	2.1	0.39
27	0.25	0.15	3.1	0.20	-	-
29	0.3	0.17	3.1	0.29	-	-
30	0.6	0.35	3.5	0.45	-	-
32	0.3	0.01	-	-	-	-
37	0.8	0.13	2.8	0.09	4.2	0.20
40	0.1	0.14	2.6	0.21	-	-
42	0.3	0.13	2.8	0.23	-	-
43	0.8	0.10	-	-	-	-
47	0.1	0.08	2.4	0.14	-	-
48	0.1	0.23	2.7	0.23	-	-
50	0.1	0.03	2.4	0.07	2.8	0.07
72	0.5	0.26	3.9	1.28	3.2	0.35
73	-	-	2.9	1.31	-	-
74	-	-	2.8	0.08	-	-
75	-	-	2.8	0.19	-	-
76	-	-	3.9	0.32	4.8	0.30
77	-	-	3.2	0.08	3.6	0.20

TABLE 9
Kansas River Basin
Benthic Organisms per Square Foot
Spring Survey - March-April, 1966

Organisms	Stations																				
	12	14	15	16	17	18	19	20	21	23	29	30	32	36	37	40	42	44	47	48	50
OLIGOCHAETA																					
Tubificidae	A*	-	P	P	-	-	8	68	4	17	-	-	-	48	-	-	P	P	P	621	2526
HIRUDINEA																					
Erpobdella punctata	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE																					
Sphaerium sp.	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Pisidium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	P
PULMONATA																					
Physa sp.	-	-	P	-	-	P	-	-	-	-	-	-	-	-	P	-	-	-	P	16	P
AMPHIPODA																					
Gammarus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	8	P	-	-	-	-	-	-
DIPTERA																					
Tendipedidae w/o ventral blood gills	C	C	C	C	-	-	80	-	24	20	C	-	-	44	P	A	-	C	P	64	503
Simuliidae	-	-	-	-	-	-	-	-	-	A	4	P	-	-	-	-	-	-	P	545	3218
Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	14
Tabanus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANISOPTERA																					
Gomphus sp.	-	P	-	P	-	-	P	-	-	-	-	-	-	4	-	-	-	-	-	-	-
Libellulidae	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Macromia sp.	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ZYGOPTERA																					
Hyponeura sp.	-	C	-	-	-	C	2	-	-	-	-	-	-	-	-	P	-	P	-	2	-
Agrion sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-

TABLE 9 cont'd.

Kansas River Basin - Spring Survey

Organisms	12	14	15	16	17	18	19	20	21	23	29	30	32	36	37	40	42	44	47	48	50
COLEOPTERA																					
Elmidae	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	42
Dineutus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Haliplus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
HEMIPTERA																					
Corixidae	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	P	-	-	-	-	C
MEGALOPTERA																					
Corydalus cornutus	-	-	-	P	-	P	-	-	-	-	P	-	P	-	-	-	-	-	-	2	2
TRICHOPTERA																					
Hydropsyche sp.	-	-	-	P	-	P	915	-	12	C	4	P	C	-	-	-	-	C	-	-	-
Cheumatopsyche sp.	C	-	-	-	-	P	-	-	64	C	A	-	C	-	P	-	-	-	C	9	1554
EPHEMEROPTERA																					
Stenonema sp.	-	-	-	C	-	-	29	-	12	C	-	-	-	-	-	-	-	-	P	-	-
Heptagenia sp.	C	C	C	P	-	C	-	-	-	14	12	C	A	8	-	C	-	P	-	-	-
Cinygma sp.	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Hexagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	P
Pentagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-
Blasturus sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Isoperla sp.	-	-	C	A	P	-	8	-	32	C	2	C	C	-	-	P	-	P	-	-	-
Perlidae	-	-	-	-	-	P	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
Acroneuria sp.	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-
Neoperla clymene	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
Total No. of Kinds	5	4	6	9	1	9	8	1	7	9	9	4	9	5	4	7	4	10	8	8	11
Total No. per Sq. Ft.	-	-	-	-	-	-	1057	68	148	51	139	-	-	112	-	-	-	-	-	1261	7859

*Appeared in qualitative sample and recorded as 1 in total number of kinds.
AA-very abundant; A-abundant; C-common; P-present.

TABLE 10

Kansas River Basin
Benthic Organisms per Square Foot
Summer Survey, June - July 1966

Organisms	Stations																		
	12	15	16	17	18	19	20	21	23	29	30	32	36	40	42	43	47	49	50
OLIGOCHAETA																			
Lumbriculidae	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-
Tubificidae	*P	C	-	A	A	-	P	-	P	-	P	-	4	P	C	28	92	352	173
NEMATOMORPHA																			
Gordius sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
SPHAERIIDAE																			
Sphaerium sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	C	P	-
Pisidium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22
PULMONATA																			
Physa sp.	-	-	-	-	P	-	-	-	-	-	-	-	C	-	-	-	C	C	9
Lymnea sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	9
Gyraulus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Ferrissia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
DECAPODA																			
Orconectes sp.	-	-	-	P	P	-	-	-	-	P	-	-	C	-	-	-	P	P	P
BRYOZOA	P	-	-	-	P	C	-	-	-	-	-	-	-	-	-	P	-	-	-
DIPTERA																			
Tendipedidae	A	-	A	-	P	-	A	A	C	C	-	P	236	A	-	64	20	136	58
Simuliidae	-	-	-	-	-	-	-	-	-	AA	-	-	-	-	-	C	P	-	P
Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-

TABLE 10 cont'd.

Kansas River - Summer Survey

Organisms	Stations 12	15	16	17	18	19	20	21	23	29	30	32	36	40	42	43	47	49	50
ANISOPTERA																			
Gomphus sp.	-	-	-	-	-	-	C	-	-	-	-	-	-	-	P	-	-	-	-
ZYGOPTERA																			
Hyponeura sp.	-	-	-	-	P	P	-	P	-	-	-	-	P	-	-	C	C	A	P
COLEOPTERA																			
Elmidae	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenelmis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	P	2
Halipus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Hydrophilidae	-	-	-	-	-	-	-	-	-	-	-	-	2	P	-	-	-	-	-
HEMIPTERA																			
Plea striola	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Microvelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Corixidae	-	-	-	-	P	-	-	P	-	-	-	-	-	P	-	-	-	P	-
MEGALOPTERA																			
Corydalus cornutus	-	-	-	-	-	-	-	-	-	P	-	-	-	-	C	P	-	-	-
TRICHOPTERA																			
Hydropsyche sp.	P	-	C	-	-	P	-	C	P	P	P	-	-	-	A	A	A	A	4
Cheumatopsyche sp.	-	-	-	-	-	P	-	-	P	-	-	P	-	-	-	-	A	-	-
Molanna sp.	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	C	-
Ochrotrichia sp.	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A

Kansas River - Summer Survey

TABLE 10 cont'd.

Organisms	Stations 12	15	16	17	18	19	20	21	23	29	30	32	36	40	42	43	47	49	50
EPHEMEROPTERA																			
Stenonema sp.	C	-	-	P	C	C	-	C	A	-	-	-	-	-	?	C	-	C	-
Heptagenia sp.	-	-	C	-	-	P	-	P	P	C	P	-	-	-	C	C	A	-	-
Hexagenia sp.	-	-	P	-	P	-	-	-	C	-	-	-	-	P	P	-	-	-	-
Pentagenia sp.	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	-	-
Potamanthus sp.	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Isonychia sp.	-	-	C	P	-	C	-	A	A	C	-	-	-	-	P	P	P	-	-
Ameletus sp.	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-
Caenis sp.	-	-	-	-	-	P	-	-	A	-	-	-	-	-	-	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA																			
Isoperla sp.	-	-	C	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
Perlesta sp.	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria sp.	-	-	-	-	-	-	-	-	P	P	-	-	-	-	P	-	-	-	-
Neoperla clymene	-	-	-	-	-	P	-	-	P	P	-	P	-	-	P	-	P	-	-
ORTHOPTERA																			
Tridactylus sp.	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-
Total No. of Kinds	7	1	6	4	9	12	5	8	12	11	4	3	7	8	13	12	13	12	12
Total No. per Sq. Ft.	-	-	-	-	-	-	-	-	-	-	-	-	242	-	-	92	112	488	289

*Appeared in qualitative sample and recorded as 1 in total number of kinds.
AA-very abundant; A-abundant; C-common; P-present.

TABLE 11
Kansas River Basin
Benthic Organisms per Square Foot
Fall Survey, October-November 1966

Organisms	Stations																			
	12	14	15	16	17	18	19	20	21	23	29	30	32	37	40	42	43	47	48	50
OLIGOCHAETA																				
Tubificidae	*AA	P	-	P	C	-	3	-	11	16	88	P	C	-	4	-	64	-	80	20
Branchiura sowerbyi	-	-	-	-	-	-	-	A	-	-	10	-	-	-	-	-	-	-	-	-
HIRUDINEA																				
Erpobdella punctata	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TURBELLARIA																				
Dugesia sp.	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE																				
Sphaerium sp.	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	P	P	P	C	7
Pisidium sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
PULMONATA																				
Physa sp.	P	A	-	C	C	P	-	C	C	-	P	-	-	-	-	-	-	-	-	-
Ferrissia sp.	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	P	C
UNIONIDAE																				
Lampsilis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DECAPODA																				
Orconectes sp.	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BRYOZOA	-	-	-	C	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 11 cont'd.

Kansas River - Fall Survey

Organisms	Stations																		
	12	14	15	16	17	18	19	20	21	23	29	30	32	37	40	42	43	47	48	50
DIPTERA																				
Tendipedidae																				
w/o ventral blood gills	P	-	C	P	-	-	5	-	39	A	52	10	A	P	8	P	12	5	136	40
with ventral blood gills																				
Tendipes plumosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28	-	C	-
Simuliidae	-	-	-	-	-	-	-	-	-	12	A	3	-	-	-	-	-	20	C	428
Culicoides sp.	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	P	P	-
Palpomyia sp.	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	P	-	-	16	-
Psychoda sp.	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	P	-
ANISOPTERA																				
Progomphus sp.	-	-	-	-	C	-	-	P	-	-	-	-	-	-	-	P	-	-	-	-
Gomphus sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	1	P
Neurocordula sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
ZYGOPTERA																				
Hyponeura sp.	P	C	-	P	C	-	C	C	C	4	C	P	P	-	C	-	P	P	C	-
Agrion sp.	-	-	-	P	-	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-
COLEOPTERA																				
Elmidae	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	C	P	-
Stenelmis sp.	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	12	1	P	11
Copelatus sp.	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
Dineutus sp.	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	P	-
Tropisternus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-
Helichus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Halipus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-

TABLE 11 cont'd.

Kansas River - Fall Survey

Organisms	Stations																			
	12	14	15	16	17	18	19	20	21	23	29	30	32	37	40	42	43	47	48	50
HEMIPTERA																				
Corixidae	-	-	-	-	-	-	-	-	P	P	C	C	C	P	-	-	-	-	C	P
Rhagovelia sp.	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	A	-	-	-	-
Microvelia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Metrobates sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-
Belostoma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-
MEGALOPTERA																				
Corydalus cornutus	-	P	P	P	-	-	-	-	C	-	-	-	-	-	P	-	-	-	P	-
TRICHOPTERA																				
Hydropsyche sp.	-	-	C	A	C	-	5	-	C	12	A	A	C	A	-	A	-	29	P	313
Cheumatopsyche sp.	-	-	-	-	-	-	-	-	5	-	A	7	-	-	-	-	P	23	P	A
Neureclipsis sp.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA																				
Stenonema sp.	-	-	-	P	P	C	4	-	8	P	-	P	P	P	A	P	-	1	P	-
Heptagenia sp.	-	-	-	C	-	-	C	-	-	-	A	2	P	-	2	C	-	-	-	-
Hexagenia sp.	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	C	-	-
Pentagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	-
Isonychia sp.	-	-	-	-	-	-	P	-	-	-	A	1	C	-	-	C	-	-	-	-
Ameletus sp.	-	-	-	-	-	-	-	-	3	-	P	1	C	-	-	-	-	-	-	-
Caenis sp.	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-
Tricorythodes sp.	-	-	-	-	-	-	1	-	-	-	-	P	-	-	-	-	-	-	-	-
PLECOPTERA																				
Isosperla sp.	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Perlidae	-	-	-	-	-	-	-	-	-	-	-	7	P	-	-	-	-	-	-	-
Paragnetina sp.	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COLLEMBOLA																				
Isotomurus palustrus	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. of Kinds	4	5	4	12	6	4	13	5	14	11	17	15	11	4	7	13	8	13	18	10
Total No. per Sq. Ft.	-	-	-	-	-	-	60	-	70	52	152	31	-	-	14	24	120	109	236	819

*Appeared only in qualitative sample and recorded as 1 in total organisms found. AA - very abundant; A - abundant; C - common; and P - present.

TABLE 12
Benthic Organisms per square foot
Kansas River Basin
Reconnaissance Study
1966

Organisms	Date:	Stations 00-A 4-5	00-B 4-5	00-C 4-5	01 3-30	11 4-5	15 7-25	22 11-1	24 7-27	25 7-27	26 7-27	31 7-25	33 6-15	33 7-26	34 7-26	35 7-26	38 7-27	39 7-27	41 7-28	45 7-26	51 7-25	52 7-26	54 7-28	55 6-6	55 7-25	57 6-16	57 7-25	58 7-25	58 11-3	59 6-17	59 11-2	63 7-27	69 6-16	70 7-27	71 11-2
OLIGOCHAETA																																		
Tubificidae		-	-	5052	5120	A	P	20	P	P	P	-	-	-	-	-	C	C	A	A	P	-	P	-	C	-	-	-	-	A	1092	-	P	P	116
HIRUDINEA																																		
Erpobdella punctata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
NEMERTEA																																		
Prostoma rubrum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-
SPHAERIIDAE																																		
Sphaerium sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	A	-	P
PULMONATA																																		
Physa sp.		-	-	-	-	-	A	-	-	-	-	P	-	-	-	-	-	P	-	P	C	-	-	-	-	P	P	A	C	-	A	A	A	-	A
Lymnea sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Ferrissia sp.		-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UNIONIDAE																																		
Lampsilis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
AMPHIPODA																																		
Gammarus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-
DECAPODA																																		
Orconectes sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	P	-	-	P	C	-	P	C	-	-
ISOPODA																																		
Lirceus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-
BRYOZOA		-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-
DIPTERA																																		
Tendipedidae		-	-	-	-	C	A	-	P	C	C	A	-	P	P	-	-	P	A	P	A	-	C	P	P	C	P	P	A	P	-	A	-	P	108
Ceratopogonidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Culicoides sp.		-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Palpomyia sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	C	-	-	-	-	-	-	-	-	-	-	-	-	-	28
Bezzia sp.		-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simuliidae		-	-	-	-	-	-	-	-	P	P	-	-	-	-	P	-	-	P	P	-	-	-	-	-	-	-	-	C	-	-	-	-	-	A
Tipula sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neurocordula yeguyi		-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANISOPTERA																																		
Gomphus sp.		-	-	-	-	-	-	-	P	-	-	-	-	-	P	-	-	-	-	P	C	P	P	-	-	P	-	-	-	P	-	-	-	-	-
Progomphus sp.		-	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	P	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	A
ZYGOPTERA																																		
Nyphoeura sp.		-	-	-	-	P	C	-	P	-	P	P	P	-	-	-	-	-	C	P	-	-	-	C	C	P	P	-	C	P	C	P	-	-	-
Agrion sp.		-	-	-	-	-	-	-	P	-	-	-	-	-	-	C	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Libellulidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COLEOPTERA																																		
Elmidae		-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-
Stenelmis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	C	-	-	-	-	-	P	-	-	-	-	P
Dubiraphia sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dystiscidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	P	-	P	-	P	-	-
Hydroporus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 12 cont'd.

Organisms	Date:	Stations 00-A 4-5	00-B 4-5	00-C 4-5	01 5-30	11 6-5	15 7-25	22 11-1	24 7-27	25 7-27	26 7-27	31 7-25	33 6-15	33 7-26	34 7-26	35 7-26	38 7-27	39 7-27	41 7-28	43 7-26	51 7-25	52 7-25	54 7-28	55 4-4	55 7-25	57 6-16	57 7-25	58 7-25	58 11-3	59 6-17	59 11-2	63 7-27	69 6-16	70 7-27	71 11-2
Tropisternus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Berosus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enochrus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymbiodyta sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	P	-	-	-	-	-	-	-	-	-	P	-	-	-
Helipus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	P	-	-	-	-	-	-	-	-
Dineutus sp.		-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Haliplus sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Helodidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	P	-	P	-	-	-	-	-	-	-
HEMIPTERA																																		
Corixidae		-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	P
Ranatra sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	P	-	-	-	C	-	P	P	-	C	-	-	P	P	-	-
Rhagovelia sp.		-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-
MEGALOPTERA																																		
Corydalus cornutus		-	-	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRICHOPTERA																																		
Hydropsyche sp.		-	-	-	-	P	-	-	C	A	P	C	A	-	-	C	-	-	-	C	P	-	P	-	-	-	-	-	P	-	-	P	-	P
Cheumatopsyche sp.		-	-	-	-	-	-	-	P	C	-	C	-	-	P	P	-	-	-	C	P	-	P	-	-	-	-	-	-	-	-	P	-	P
Leptoceridae		-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	C	P	-	P	-	-	-	-	-	-	-	-	-	-	-
Leptocella sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	P	-	-	-	-	-	-	-	-	-	-	-	F	F
Ochrotrichia sp.		-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	A	-	A	F
Molanna sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ryacophila sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-
EPHEMEROPTERA																																		
Stenonema sp.		-	-	-	-	-	P	-	P	P	A	-	-	P	-	-	-	-	-	C	-	-	-	-	-	-	P	-	-	-	-	-	-	-
Heptagenia sp.		-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	F	A	F	-	-	-	C	C	-	-	-	-	-	C	-	C
Heptagenia sp.		-	-	-	-	-	-	-	-	-	-	P	P	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	C	C
Leucrythis sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus sp.		-	-	-	-	-	-	-	A	A	A	P	C	-	-	-	-	-	-	A	-	-	-	-	C	-	-	-	C	-	-	C	-	-
Caenis sp.		-	-	-	-	-	A	-	-	A	C	C	-	-	-	A	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	20
Tricorythodes sp.		-	-	-	-	-	C	-	P	A	A	-	P	C	-	C	-	-	F	C	-	P	-	-	-	-	-	-	-	-	-	C	C	P
Paraleptophlebia sp.		-	-	-	-	-	-	-	-	-	P	-	C	C	P	C	-	-	C	P	P	A	-	-	-	-	-	-	-	-	-	-	-	-
PLECOPTERA															P	C	-	-	C	A	-	-	C	-	-	-	-	P	-	-	-	C	-	C
Isoperla sp.		-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria sp.		-	-	-	-	-	-	-	P	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cleaneuria sp.		-	-	-	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total no. of kinds		0	0	1	1	8	9	1	13	11	11	9	7	5	8	10	1	7	10	22	9	8	7	3	7	10	8	8	6	7	4	14	9	10	17
Total no. per sq. ft.		-	-	5052	5120	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1092	-	-	-	296

*Appeared in qualitative sample and recorded as 1 in total number of kinds.
AA-very abundant; A-abundant; C-Common; P-present.

TABLE 13
Lower Kansas River
Benthic Organisms per square foot
Summer Survey, July 1966

Organisms	Stations																										
	00			02			03			04			05			06			07			08			09		11
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	C	
OLIGOCHAETA																											
Tubificidae	1020	720	1008	4656	296	84	72	8	60	3600	372	44	696	4800	492	5574	252	36	208	64	36	-	4	1324	28	1328	AA*
DIPTERA																											
Tendipedidae	-	-	8	-	4	-	4	-	4	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	20	-
Psychodidae	-	-	-	-	-	-	4	-	4	40	-	8	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Chaoborus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-
COLEOPTERA																											
Stenelmis sp.	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Tropisternus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Total No. of Kinds	1	1	2	1	2	1	3	1	3	2	1	2	1	1	1	1	1	2	1	2	1	0	1	2	2	2	3
Total per Square Ft.	1020	720	1016	4656	300	84	80	8	68	3640	372	52	696	4800	492	5574	252	40	208	72	36	0	4	1328	32	1348	-

*Appeared in qualitative sample and recorded as 1 in total number of kinds.
AA-very abundant; A-abundant; C-common; P-present.

TABLE 14
Lower Kansas River Survey
Benthic Organisms per square foot
Fall Survey, Oct., 1966

Organisms	Stations 00 A	00 B	00 C	02 A	02 B	02 C	03 A	03 B	03 C	04 A	04 B	04 C	05 A	05 B	05 C	06 A	06 B	06 C	07 A	07 B	07 C	08 A	08 B	08 C	09 A	09 B	09 C	10 A	10 B	10 C
OLIGOCHAETA																														
Tubificidae	7700	10,800	6400	26,400	6600	1148	8800	6400	736	18,400	10,400	2800	7600	8400	7600	4800	2132	172	3864	3360	8	40	1148	2240	-	88	584	284	552	20
TURBELLARIA																														
Dugesia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P*
PULMONATA																														
Physa sp.	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-	-	-
BRYOZOA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A
DIPTERA																														
Tendipedidae	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	48	8	-	20	20	20	5
Culicoides sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-
Chaoborus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
ZYGOPTERA																														
Hyponeura sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-	P
COLEOPTERA																														
Stenelmis sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	C
TRICHOPTERA																														
Hydropsyche sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	AA
EPHEMEROPTERA																														
Hexagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	1	15
Heptagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P
Total No. of Kinds	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	3	1	2	2	2	2	1	1	3	3	3	9
Total per Sq. Ft.	7700	10,800	6400	26,400	6600	1152	8800	6400	736	18,400	10,408	2800	7600	8400	7600	4800	2132	172	3980	3360	12	44	1164	2288	8	88	608	312	572	40

*Appeared in qualitative sample and recorded as 1 in total number of kinds.
AA-very abundant; A-abundant; C-common; P-present.

Table 15

Key to the Predominant Phytoplankton Genera
(Tables 16, 17, 18, 19, 20, 21)

Centric Diatoms

a. Cyclotella - Stephanodiscus
b. Melosira

Pennate Diatoms

c. Asterionella
d. Nitzschia
e. Navicula
f. Unidentified

Greens

g. Scenedesmus
h. Ulothrix
i. Ankistrodesmus
j. Actinastrum

Blue-Greens

k. Unidentified

Flagellates

l. Trachelomonas
m. Euglena
n. Chlamydomonas
o. Unidentified

Table 16

Kansas River Basin
Spring Survey 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
12	3-27	59,600	190	4,060	0	9,090	72,940	a,1,o
14	4-4	62,000	390	3,380	190	3,290	69,250	a
15	3-27	60,700	0	3,290	0	10,400	74,390	a,1,o
16	3-27	40,000	190	3,480	0	5,610	49,280	a,1
17	4-4	26,900	1,350	2,130	0	4,840	35,220	a,1
18	3-27	36,000	2,320	2,900	190	7,350	48,760	a,1,o
19	3-27	42,400	390	1,740	0	6,190	50,720	a,1,o
20	3-30	37,100	580	3,090	0	3,770	44,540	a,1
21	3-25	28,700	930	700	80	3,170	33,580	a,1
23	3-27	25,300	1,160	580	770	4,250	32,060	a,1
29	3-27	45,100	1,550	2,510	0	8,900	58,060	a,o,1
30	3-27	26,110	580	190	0	3,480	30,360	a
32	3-27	24,000	770	970	0	2,130	27,870	a
36	3-27	5,420	230	0	0	850	6,500	a
37	3-28	3,790	80	40	0	80	3,990	a
40	3-27	7,740	160	160	0	5,570	13,630	a,1
42	3-27	37,900	390	5,220	190	11,220	54,920	a,o
43	3-27	8,510	1,840	580	100	2,510	13,540	a,1
47	3-27	11,800	580	970	0	3,480	16,830	a
48	3-27	9,210	1,620	1,010	0	2,480	14,320	a,1
50	3-27	67,300	8,940	1,470	0	850	78,560	a,e,d

ETO

Table 17

Kansas River Basin
Summer Survey 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
12	6-27	10,400	100	4,930	190	2,510	18,130	a
14	-	-	-	-	-	-	-	-
15	6-17	1,510	310	1,320	160	420	3,720	a,j
16	6-17	3,750	500	1,200	170	540	6,160	a,g
17	6-17	6,960	1,160	4,260	390	3,290	16,060	a,m,o
18	6-17	7,350	1,840	2,320	480	970	12,960	a,g
19	6-16	9,480	1,350	5,420	580	3,290	20,120	a,i
20	6-16	4,450	970	3,680	1,160	3,290	13,550	a,o
21	6-16	2,510	1,550	2,510	190	1,160	7,920	a,d
23	6-16	1,160	580	6,380	770	3,090	11,980	o
29	6-16	1,350	190	2,510	0	3,380	7,430	o
30	6-16	2,710	0	390	0	390	3,490	a
32	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-
37	6-20	2,050	770	660	0	460	3,940	a
40	6-16	580	190	0	100	290	1,160	-
42	6-16	1,350	2,130	11,600	580	1,160	16,820	g,j
43	6-16	680	390	4,550	190	770	6,580	i
47	6-16	3,290	970	6,770	190	1,350	12,570	a,g,i
48	6-20	1,550	770	3,090	0	5,030	10,440	a,o,g
50	6-15	1,160	2,510	1,350	190	3,870	9,080	o

Reproduced from best available copy.

Table 18

Kansas River Basin
Fall Survey 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
12	11-3	17,400	6,770	4,060	190	7,160	35,580	a,d,o
14	11-3	5,420	1,350	1,550	0	1,740	10,060	a,o,d
15	11-3	7,160	1,260	480	390	3,290	12,580	a,o,d
16	11-3	5,030	4,640	970	390	1,930	12,960	a,d,o
17	11-2	2,510	2,900	1,550	390	1,550	8,900	a,d
18	11-2	6,770	1,350	2,130	0	3,090	13,340	a,o,d
19	11-2	5,420	1,160	1,740	390	2,320	11,030	a
20	11-2	7,540	1,550	2,510	0	2,510	14,110	a,o
21	11-2	8,320	970	3,090	0	2,130	14,510	a,o,g
23	11-1	1,740	1,160	1,350	580	2,320	7,150	a,d,o
29	11-1	9,860	2,510	1,550	0	2,710	16,630	a,b
30	11-1	160	310	80	0	190	740	-
32	11-1	270	190	0	0	540	1,000	o
36	-	-	-	-	-	-	-	-
37	11-1	580	100	0	0	390	1,070	-
40	11-3	2,130	190	580	970	5,610	9,480	o,a
42	11-1	1,160	770	2,130	0	3,480	7,540	o,i
43	10-31	390	4,840	100	190	1,930	7,450	d
47	11-1	2,130	390	970	190	1,550	5,230	a,o
48	10-31	870	770	1,060	0	580	3,280	a,i
50	10-31	580	5,030	190	190	390	6,380	d

Table 19

Kansas River Basin
Reconnaissance Studies, 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
00	4-5	47,800	1,160	5,420	0	6,190	60,570	a, l
00	6-20	9,980	770	3,400	460	1,860	16,470	a, g
00	6-27	26,100	4,330	11,000	930	2,320	44,680	a, g
01	3-30	39,800	1,320	4,640	0	7,350	53,110	a, l
15	7-25	12,000	4,450	4,060	2,320	3,290	26,120	a, c, o
22	11-1	2,710	2,900	2,900	0	3,870	12,380	a, d, o
24	7-27	1,160	1,450	480	0	0	3,090	a
25	7-21	1,160	1,930	1,550	390	0	5,030	d, a
26	7-27	0	1,160	390	0	0	1,550	f
27	6-16	770	190	1,350	0	1,350	3,660	g
31	7-25	390	970	770	390	970	3,490	d
33	6-15	1,550	390	190	190	1,550	3,870	a, o
33	7-26	1,160	190	1,930	190	770	4,240	a
34	7-26	1,840	870	3,090	100	580	6,480	a, h
35	7-26	580	3,190	870	190	1,060	5,890	d, f, o
38	7-27	770	1,550	1,930	190	390	4,830	a, i
39	7-27	3,680	6,380	970	0	190	11,220	d, a
41	7-28	390	1,040	80	40	580	2,130	d
45	7-26	580	1,160	1,060	0	770	3,570	-
51	7-26	8,320	3,480	4,260	770	2,130	18,950	a, i, d
52	7-26	390	580	0	0	480	1,450	-
54	7-28	1,160	190	1,740	0	970	4,060	a
55	4-4	28,800	770	2,320	0	2,900	34,790	a
55	7-25	770	190	0	0	3,870	4,830	l, a
56	7-25	390	1,350	580	190	3,480	5,990	m, o
57	6-16	540	120	270	40	770	1,740	a
57	7-25	1,060	16,400	580	190	7,160	25,390	d, o
58	4-4	3,300	1,200	270	0	0	4,770	a, e
58	7-25	5,420	4,640	970	580	4,450	16,060	a, d, o
58	11-3	350	500	80	0	810	1,740	e

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
59	11-2	390	8,800	190	580	580	10,540	d
62	7-26	190	390	100	10,250	100	11,030	k
63	7-27	580	2,900	1,160	0	390	5,030	d
65	7-26	480	100	480	870	970	2,900	-
69	6-16	6,960	1,350	1,160	0	11,220	20,690	a, o, n
70	7-27	770	2,510	580	0	480	4,340	d
71	11-2	870	580	1,640	190	1,840	5,120	i, o
72	6-20	67,150	3,710	11,300	160	5,110	87,430	a, g
72	6-27	1,860	0	230	0	460	2,550	a
73	6-20	1,280	160	580	0	2,050	4,070	a, o
73	6-27	1,930	1,930	0	0	970	4,830	-
74	6-20	770	1,560	390	0	5,030	7,750	q
74	6-27	8,220	480	2,610	190	1,640	13,140	o, a
75	6-20	15,600	37,100	24,100	0	9,280	86,080	d, a
75	6-27	23,000	48,200	9,670	390	4,260	85,520	d, a, c
76	6-20	6,190	5,720	8,050	770	2,940	23,670	a, c
76	6-27	80	270	40	0	40	430	-
77	6-20	410	120	210	0	350	1,090	a
77	6-27	580	460	160	0	310	1,510	a

Table 20

Lower Kansas River
Summer Survey 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
00	7-7	32,800	2,170	3,870	1,700	2,780	43,320	a,i,d
02	7-7	32,200	3,250	2,320	930	1,390	40,090	a,d
03	7-7	30,700	2,860	2,480	1,320	2,240	39,600	a,d
04	7-7	29,900	3,170	2,480	770	1,700	38,020	a,d
05	7-7	29,400	3,170	2,940	540	1,550	37,600	a,d
06	7-7	23,800	3,710	2,480	620	1,240	31,850	a,d
07	7-6	19,800	4,490	2,780	1,860	2,940	31,870	a,d,o
08	7-6	17,800	4,180	1,080	310	1,390	24,760	a,d
09	7-6	22,300	3,250	2,630	620	1,860	30,660	a,d

Table 21

Lower Kansas River
Fall Survey 1966
Phytoplankton per Milliliter

Station Number	Date	Kind of Algae: Centric Diatoms	Pennate Diatoms	Greens	Blue-Greens	Flagellates	Total	Predominant Genera
00	10-4	23,200	970	4,840	770	2,510	32,290	a
02	10-4	19,500	190	5,220	2,130	7,930	34,970	a,o,n
03	10-4	19,900	1,160	4,450	580	6,770	32,860	a,o
04	10-4	15,300	770	5,420	0	6,190	27,680	a,o
05	10-4	14,700	390	2,900	190	6,000	24,180	a,o
06	10-4	16,600	970	5,030	390	2,900	25,890	a,o
07	10-5	27,300	390	5,030	1,160	2,320	36,200	a,j
08	10-5	13,900	580	3,090	390	4,840	22,800	a,o
09	10-5	11,200	580	4,260	770	1,930	18,740	a
10	10-5	21,800	1,930	3,290	190	4,450	31,660	a.